THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[THIRD SERIES.]

ART. XXXIX.—*On some Phenomena of Binocular Vision;* by JOSEPH LECONTE, Prof. Geol. and Nat. Hist., University of California.*

VI. *So-called "images of illusion;" and the theory of binocular relief.*

IN a very elaborate paper on binocular vision published in the Archives des Sciences† for Feb., 1871, which is itself but a succinct resumé of a much more extended memoir soon to be published, M. Pictet undertakes to establish on a firm basis the "*nativistic*" theory which regards *corresponding points* as *congenital* and the result of *anatomical structure*, as opposed to the "*empiristic*" theory which regards them as the *result of experience.* After summing up the usual arguments and objections on each side, he proceeds, as he thinks, to prove the truth of the former theory by showing, first, *a priori*, the consequences which must flow from the admission of this theory; second, that the visual results of certain experiments are precisely what *a priori* reasoning leads us to expect; and third, that this theory, in the form in which he maintains it, explains all the more obvious phenomena of binocular vision.

The one strikingly new thought in M. Pictet's memoir is the supposed existence of "*images of illusion*" in every act of vision. *This* it is which follows, he thinks, from the admission of the nativistic theory; it is *this* which he attempts to prove by all his experiments; it is by means of *this* that he solves all the

* For previous papers on this subject see II, vol. xlvii, pp. 68, 153; III, vol. i, p. 33, and vol. ii, p. 1.

† Arch. des Scien., nouv. per tome xl, p. 105.

vexed questions of binocular vision. Now while I believe the evidence is overwhelmingly in favor of the nativistic theory, i. e., the *congenital* existence of corresponding points, yet I feel perfectly confident that the existence of M. Pictet's images of illusion, from their very nature, cannot be proved; and that all the phenomena which he adduces as proof may be easily explained by the known laws of binocular vision. Passing over, therefore, the many interesting questions touched upon in M. Pictet's very suggestive paper, I will confine myself wholly to M. Pictet's *illusive images;* my sole object being to rescue the theory of binocular vision from the confusion into which it has been thrown by the introduction of this new idea.

In order to account for single vision with two eyes, Müller supposed that the nerve fibers which terminate *peripherally* in identical points of the retinæ (*corresponding fibers*) are *centrally* fused into *one fiber*, or *terminate centrally in one brain cell.* M. Pictet admits that the nativistic theory is by no means dependent on this assumption—the existence of corresponding or identical points as a congenital fact, by whatsoever structural contrivance effected, being all that is contemplated by this theory—yet all his reasonings are based upon, and all his experiments are intended to prove, *an alliance* between corresponding fibers *equivalent to* the *fusion* of Müller. For M. Pictet, corresponding fibers under all conceivable circumstances behave *like*, and therefore *are* substantially, a *single bifurcating fiber.* Assuming, then, an anatomical structure equivalent to fusion of corresponding fibers into one in the brain, M. Pictet proceeds to show that, by the well-known physiological law which refers all impressions on the nerve *centers* to the *peripheral extremities of the nerve fibers*, an impression made upon any point of *one retina*, being carried to the brain, would thence be necessarily referred back to *both extremities* of the bifurcating fiber, i. e., *to corresponding points of both retinæ.* Therefore, if luminous rays from an object impress the *retina of one eye*, the impression transmitted to the brain must be referred back *equally to both eyes*, producing *two identical external images* in the field of view; the one a *true image* produced by the luminous impression on the retina of one eye, the other an "*image of illusion*"—a subjective or spectral image—*reflected* from the *point of alliance* within the brain to the *retina of the other eye.* According to M. Pictet, therefore, even *when we shut one eye* we still, in a certain sense, *see objects with both eyes;* for there is a true image belonging to the open eye and an illusive image to the closed eye. These two images are *identical* and seen at the *same place.* Stereoscopic effects are not observable in monocular vision only because these two images are *perfectly identical* and *perfectly united.*

It is easy to see, from the perfect identity and the inseparable union of the true and illusive images, how difficult, nay, even *impossible* and therefore futile, to attempt to prove the existence of the latter. Nevertheless, M. Pictet details several experiments which, he thinks, prove beyond doubt the existence of such illusive images in every act of vision. I wish to show that the phenomena of M. Pictet's experiments may be explained without resorting to illusive images. Before doing so, however, I find it necessary to state very concisely certain general principles of binocular vision which I shall use in their explanation, referring the reader to my previous papers for a fuller statement and proof. Throughout this paper I shall refer back to these principles by means of the numerals affixed.

1. The impressions produced by *luminous retinal images* are transmitted to the brain and, by a psychological law, are projected outward into the external world and seen there as *external images.* Each eye has its *own field of view* crowded with *its own images.* As these images are usually seen *double,* it will often be convenient to regard them not as *objects* but as external *images,* the signs of objects. Only when the two images formed by the same object are superposed do we see the object *single* and *in its true position.* This takes place when the *luminous* images fall on *corresponding points.* The two retinal images on corresponding points are *seen* externally as a *single* image or object. It is true this may be regarded as *really a single image —the sign of the fusion of the nerve fibers.* But since we can move about the *two* images of the *same* object, bring them near together, unite them partly or unite them wholly, as we please; and since, moreover, we can even take images of *different* objects and superpose them, and if they be similar, unite them so as to appear as *one* object, it is better, because it more easily explains visual phenomena, to regard single binocular vision as the result of the *superposition of two images.*

2. In binocular vision with the optic axis parallel, as in gazing at a distant object, the whole field of view and all objects in the field, including the visible parts of the face, are shifted by the *right* eye a half interocular space to the *left,* and by the left eye the same distance to the right, without altering the relative position of parts; so that the two eyes and their visual lines seem to unite to form a *single binocular eye,* and a *single middle visual line* along which the eye seems to look. Any line, rod or plane in the median line, as also the nose itself, is *doubled heteronymously,* and becomes two lines, rods or planes, parallel to each other, and separated by a space exactly equal to the interocular space. Between the two noses and between the two parallel lines, rods or planes, the combined eyes seem to look out along the combined visual lines upon the distant object.

Of course, by this shifting of the two fields all objects are similarly doubled.

Thus in binocular vision the two eyes *seem* actually to be superposed and corresponding points to coincide. This apparent combination of the eyes and their visual lines is the necessary result of the existence of corresponding points. Images on corresponding points are seen single; all objects in the two visual lines must impress corresponding points; therefore the visual lines themselves, if they were visible lines, would be seen single. This can take place only by combining to form a single *middle* visual line.

3. In turning the eyes in any direction *without altering their convergence* objects seem stationary, and the visual lines seem to move and sweep over them. But when we turn the two eyes in *opposite directions*, as in strong convergence, then the *visual lines seem stationary* (i. e., we seem to look in the same direction), and *all objects or rather images seem to move in a direction contrary to the actual motion of the eye;* the whole field of view of each eye with all its images rotates about the optic center in a direction contrary to the rotation of the eye. This is plainly seen by voluntarily and strongly converging the eyes upon an imaginary point near at hand, and at the same time watching the movements of the more distant images. The whole field of view of the right eye with all its images will be seen to rotate to the right and of the left eye to the left, i. e., *homonymously.* The images of all objects as they are swept successively by the visual lines of the two eyes are brought successively in front and superposed. If we could turn our eyes outward, the fields and their images would move heteronymously. This is seen to a limited extent in the act of falling to sleep.* Even with the two eyes *turned outward*, therefore, the two visual lines are united *in front*, and objects on the visual lines are brought in front and superposed. This is the necessary result of the properties of corresponding points; but I have also proved it by observations made upon persons whose eyes in a perfectly passive state turned slightly outward.*

Thus, there are two *apparent* movements of the visual fields accomplished by the eyes in binocular vision: 1st, a *shifting* of each field *heteronymously* a half interocular space; this is involuntary and habitual, and would of itself double all objects heteronymously; 2d, in ocular convergence, a *rotation* of each field about the optic center *homonymously.* The necessary consequences of these movements are: (a) that the two images of *an object at the point of sight* are superposed and the object is seen single; objects on *this side* the point of sight are doubled heteronymously, while objects beyond the point of sight are doubled

* The proof of this statement I hope to give shortly in a separate article.

homonymously; (b) that all objects (*different objects*) lying in the visual lines, whether on this side or beyond the point of sight, have two of their images (one of each) superposed; so that the two visual lines *under all circumstances* are combined to form a binocular visual line passing from the combined eyes, through the point of sight, and onward to infinite distance.

Let us now, in the light of these facts, examine M. Pictet's experiments. I will pass over for the present what he seems to regard as his crucial experiments, and take up first the general phenomena of double images, as a proper understanding of the nature of these will make all that follows clear.

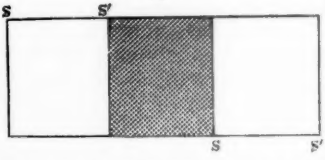
If we hold up a finger before the eyes, and gaze at the wall on the opposite side of the room, two heteronymous images of the finger will be seen separated by a space nearly equal to the interocular space. As a question of geometry this is sufficiently explained by the different parallactic position of the finger as seen by the two eyes; as a question of binocular vision, by the shifting of the fields of view of the two eyes heteronymously as already explained (2).

But the images are *transparent.* M. Pictet lays much stress on this. It is, he says, "an essential point which we have not found in works on optical physiology" (p. 105). He explains it as follows: There is a part of the wall which sends no luminous rays to the right eye (viz: that covered by the right-eye image); but this part impresses the left eye, and this impression is *propagated* to the right eye, and perceived by it at the same place as an *illusive image.* The finger, therefore, will appear transparent to the right eye because by means of an illusive image the wall is seen behind it. The same explanation of course applies to the left-eye image of the finger, which is transparent, according to M. Pictet, because the left eye sees the wall behind it by means of an illusive image propagated from the right eye. Now *our* explanation is entirely different; and we cannot but think that the transparency of double images have been so little noticed by writers only because their explanation seemed so obvious. Our explanation is as follows: We see *every* part of the wall because *no* part is concealed from *both* eyes. The images must seem transparent since they conceal nothing from *the observer.* M. Pictet would say the right-eye image conceals nothing from the right eye, and the left-eye image nothing from the left eye, and therefore the parts covered by these images must be seen, by the corresponding eye, by means of illusive images; but *we* say, a part of the wall *is* concealed from the right eye (viz: that upon which the right-eye image falls), but this part is visible to the left eye; similarly, a part of the wall *is* concealed from the left eye, but this part is visible to the right. M. Pictet says, every part of the wall is

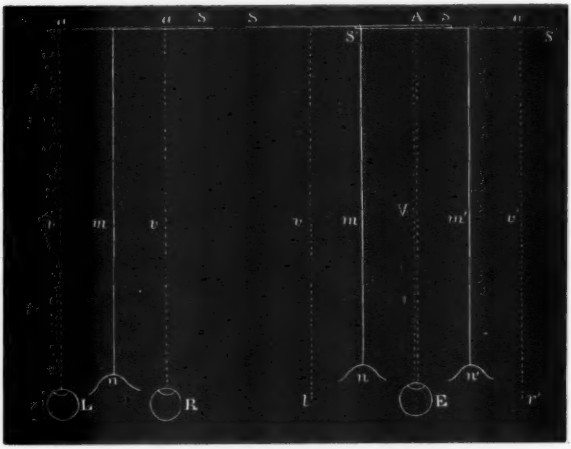
seen by *each* eye, either by true or by illusive images; we say, every part of the wall is seen, not by each eye, but by the *binocular observer;* not some parts by true and some by illusive images, but only by *true images.*

If instead of a finger we use a screen several inches wide (wider than the interocular space), then the double images will not entirely separate. They will slide over each other heteronymously through a space equal to the interocular space (2). The overlapping area will be opaque because it covers a portion of the wall concealed from both eyes; the rest will be transparent. The visual result is represented by fig. 1, in which S S is the right-eye image of the screen, S′ S′ the left-eye image, and S′ S the overlapping area. These facts are more completely represented by my method in figs. 2 and 3, of which fig. 2 represents the actual relation of parts, and fig. 3 the visual result. In fig. 2, R and L are the right and left eye respectively, *n* the nose,

1.



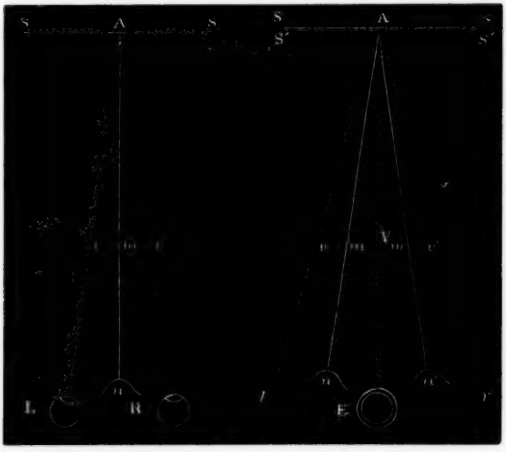
2. 3.



m the median line, *v v* the visual lines, S S the screen. Fig. 3 will readily explain itself if the reader will call to mind that in all my figures representing visual results capitals represent combined images, small italics right-eye images, and dashed italics left-eye images. If now the optic axes be gradually converged, as already explained (3), these heteronymous images will slide over each other homonymously, making the opaque area larger and larger, and the transparent margins smaller and

smaller, until when the point of sight is at the screen, fig. 4, then the images will *completely unite*, and the screen become *entirely opaque*. This is shown in the visual result, fig. 5.

4. 5.



If next we use *two* fingers, one of each hand, and gaze again at the wall, we will see four images all transparent. Now approximate or separate the two fingers until the two middle images unite; we will have three images, the middle one *opaque*, the other two transparent. The reason is obvious. The middle one is opaque because a portion of the wall is concealed by it from *both eyes*. This portion of the wall is concealed from the right eye by the right finger, and from the left eye by the left finger; but it is the right-eye image of the right finger and the left-eye image of the left finger which unite to form the middle opaque image, while the right-eye image of the left finger is seen to the left, and the left-eye image of the right finger to the right, both *transparent*. In binocular vision, *superposed images* of opaque objects are *always opaque*, while *single images* are *always transparent*.

The principles (1, 2, 3) laid down in the early part of this paper, together with the explanation of transparent double images just given, furnish, we believe, the key to all M. Pictet's experiments. We will make the application only to those which he thinks most conclusive of the existence of illusive images. We will first give his experiments and his conclusions as fairly as we can, and then will proceed to give our own explanation. The following experiments M. Pictet thinks conclusive:

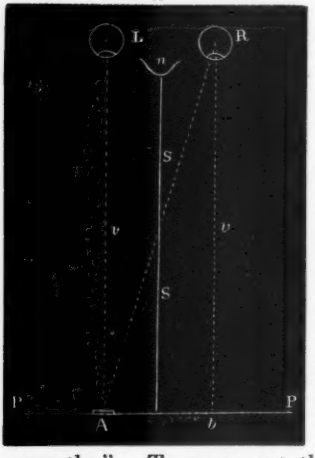
Place an opaque screen S (fig. 6) against the nose *n* in the *median plane of sight*, in such wise that the object A may be

seen by both eyes. Now place a second screen C across the visual line A R of the right eye, so as to intercept rays from the object A to the right eye. Nevertheless, the object A will be seen *apparently* through the opaque screen C, which will therefore appear *transparent*, and may even be drawn in outline with accuracy on the screen at *b exactly where the visual line of the right eye pierces the screen*—exactly where, if the screen were transparent ground glass, we would see it with the right eye, and might trace its outline. M. Pictet thinks this absolutely inexplicable, except on the assumption that an illusive image is actually seen at A by the right eye; and that it is this that we draw in outline on the screen at *b*, the screen being transparent because the illusive image is seen beyond.

6.

But M. Pictet gives another experiment which he thinks still more conclusive. On a sheet of paper lying on the table place a piece of money; then place a screen upright on the right side of the money, and let the face of the observer be brought down upon the screen, so that the latter being in the median line *shall intercept the view of the right eye.* Nevertheless, says M. Pictet, "on directing the regard upon the piece of money, we see that the vertical screen appears transparent throughout, and that *it permits the right eye to distinguish the piece*, as if through a very diaphanous surface." "If now we give to the optic axes a direction more parallel, we see the image of illusion of the right eye move gradually toward the right, traverse the line of intersection of the screen and the table, and come to project itself on the other side upon the paper, where we may trace its outline correctly." To represent these facts more clearly I give the diagram, fig. 7. In this figure R and L are the two eyes, *p p* the sheet of paper, A the money in the direction of the visual line of the left eye, S S the median screen, A R the visual line of the right eye when we look at the piece of money A and seem to see it through the screen, R *b* the visual line of

7.



the right eye when the optic axes become parallel, and *b*, *exactly where the visual line of the right eye pierces the paper*, the place where the outline of the piece may be traced. The image moves to the right or left according to the position of the optic axes, being always where the visual line pierces the paper. But "the most advantageous position of the optic axes," says M. Pictet, "is parallelism, for it is that which *removes the farthest the image of illusion from the real image.*" I wonder that M. Pictet did not reflect that, being on corresponding points, by his own principle *the image of illusion*, if any, *cannot be separated from the real image;* and that *there is in fact but one image seen.*

But furthermore, if a convex lens be placed across the visual line of the right eye R *b*, the image at *b* will not be affected, but the *tracing* we make of the image will be found as much smaller than the money as the lens magnifies; showing that the image is not magnified but the drawing is magnified, and therefore, M. Pictet thinks, that the *image of the money is illusive or subjective, while the image of the paper and of the tracing is real.* If, however, the lens be placed before the *left eye*, the image is magnified because, thinks M. Pictet, this image is the *illusive right-eye fac-simile of the magnified real image of the left eye.*

One more step of M. Pictet's proof. By keeping both eyes open, objects in the microscopic field may actually be drawn with accuracy on a sheet of paper placed on one side of the microscopic tube. Or, still better, if a stereoscopic card, having a picture on one half and the other half blank, be placed in the stereoscope, we may trace the picture on the blank half. According to M. Pictet's view, the light impresses one eye, and this impression is propagated as an illusive image to the other eye, and thrown on the paper just where the visual line pierces it.

Such are the most important experiments upon which M. Pictet bases his belief in the existence of illusive images. I have been familiar with all these phenomena for many years; I have also often used the method of tracing microscopic objects recommended by him; but my explanation is wholly different. If M. Pictet's view be correct; and if in the experiments detailed we actually trace the outline of an *illusive image* belonging to the right eye, then where is the *true image* belonging to the left eye? We see but *one image.* M. Pictet, in accordance with his principles (although he forgets them in the passage quoted above), ought to answer, that being on corresponding points the two images are perfectly *united.* Then why call the image we outline an image of illusion? The truth is, in every case, we *trace the outline of the true image seen by the left eye;* although by the principles laid down in the early portion of this paper, or by the properties of corresponding points, we draw the outline at *a different place* from the object.

[To be concluded.]

ART. XL.—*On the position and height of the elevated Plateau in which the Glacier of New England, in the Glacial era, had its origin;* by JAMES D. DANA.

THE existence of a region of high elevation in northern America as the source of a continental glacier in the Glacial era has often been assumed, but rather because the glacier theory was lame without it than as a result of special research with respect to the extent and location of such a region. I do not propose, at the present time, to treat the subject continentally, but simply to discuss the question as to the origin of the New England glacier. If I mistake not, however, the discussion, so far as it goes, meets the requirements of the continental question, while it proves that the idea of one central glacier source for the continent is without foundation.

1. *Position of the elevated plateau.*—In my paper of last month, on the "Valley Movements of Glaciers," (p. 233) I mentioned the fact, from the observations of the Vermont Geological Survey, that the glacial scratches on Camel's Hump, Mt. Mansfield and Jay's Peak, three of the high summits of the Green Mountains in the northern two-thirds of Vermont, have a course of about S. 50° E.* In the White Mountains, 70 miles to the south of east (S. 75° E.), the direction of the scratches near the Lake of the Clouds, on the north side of Mt. Monroe, is, as I am informed by Prof. C. H. Hitchcock, at points from 5000 to at least 5200 feet above the sea, in different places, S. 34° E. and S. 54° E. (S. 20° E. and S. 40° by compass); on the north side of Mt. Clinton, 4430 feet high, (one of the White Mountain series of summits about 17 miles west of Mt. Washington), near top, S. 50° E.–S. 54° E.; and on the south peak of Mount Clinton, at a level of 4320 feet, S. 54° E. He observes further that boulders occur at a height of 5800 feet on the north side of Mt. Washington.†

These scratches, and others crossing the Green Mountains, could not have been made with the land of North America at its present level. Elevated land must have existed to the north, if they were the work of glaciers. Moreover, these scratches

* According to the Vermont Geological Report the direction of the scratches on Camel's Hump is S. 50° E. (S. 40° E., compass), on Jay's Peak, S. 50° E., and on Mt. Mansfield, situated between the two, S. 30° E., S. 55° E., S. 58° E., at different points.

† Prof. Hitchcock observed also the course S. 24° E. near the Lake of the Clouds, but it was not common; also, in the saddle between Mt. Pleasant and Mt. Franklin, 4400 feet above the sea level, S. 34° E.; and the same in the gap between Mt. Pleasant and Mt. Clinton, 4050 feet high. It would therefore appear that the course of the general glacier over the White Mountain region was about S. 55° E., and that there were variations from this course due to the lay of the land.

on the higher summits of New England, must point approximately toward the region of elevated land, or the great Icy Plateau, as we may call it, on whose slopes the movement of the glacier originated.

This seat of power in the era of ice was not the Adirondacks; for these stand (as will be seen on any map of North America, and even a map of the World) much too far to the south. The scratches point over Lake Champlain and the low hills and plains beyond, and across the St. Lawrence. On the other side of this river lies the large valley of the Ottawa, and it is almost exactly in their direction; and the prevailing trend of the scratches through its lower half is about S. 45° E. According to the table in Logan's Report for 1863 (p. 890), this is the course at Ottawa City, Hull, Rideau River at Stegman's Rapids, and Horton near Renfrew village south of the Ottawa. At Allumettes Lake, the course S. 25° E. was found; but this locality is higher up the stream, and the course may well have been due to some local influence. There can be no doubt that, if the Glacial era was a *glacier* era, the Ottawa valley ice was a part of the same great ice-stream with that which crossed the Green Mountains, but a portion nearer the source.

The Ottawa valley, including that of Montreal River (which has the course of the Ottawa and is its western head-tributary), extends to a point nearly 500 miles in an air-line from Mt. Mansfield, and 570 from the White Mountains, with an average trend of S. 65° E. But the source of Montreal River was not the source of the glacier movement; for the course of the scratches in the Ottawa, instead of corresponding with the trend of the valley, is, as stated, S. 45° E. The scratches point, therefore, to the eastward of the western source of the Ottawa, and at least as far east as the region northeast of Lake Temiscamang (the main source of the waters of the Ottawa), on the watershed between the St. Lawrence valley and Hudson's Bay. The scratches of the White Mountains and Green Mountains and those of the lower part of the Ottawa valley point alike toward this area.

It follows that the Icy Plateau, whence the great glacier took its departure, must have existed either about this part of the Canadian watershed, or in the same direction farther to the northwest; and since the line of the scratches, if carried farther to the northwest, would strike Hudson's Bay, or its western border, it is probable that this watershed was the actual position.

This view accords with the great diversity of direction in the scratches about Temiscamang Lake, they varying, according to Logan, from S. 78° E. to S. 7° W., the least easting being found on the *west* side of the Lake; the observations are,

at East Bay, S. 53° E., S. 78° E.; on the east shore S. 38° E., S. 18° E.; at West Bay, S. 15° E.; on the west shore, S. 35° E., S. 18° E., S. 14° E., S. 1° E., S. 7° W.

The courses of the scratches on the heights of northern Maine (S. 59° E. on Mt. Abraham, C. H. Hitchcock) also favors this conclusion. Again, in the part of Canada, north of northeastern Maine, on the Madawaska River, about Temiscouata Lake, Logan found scratches trending S. 54° E., S. 52° E., S. 55° E., S. 66° E., S. 48° E., S. 60° E., (with one of S. 27° E.); and these courses, if the form of the surface has not increased the easting, would point to the same watershed and the part lying between Temiscamang and Mistissinny Lakes, but nearer the latter, and these lines continued would strike into Hudson's Bay, and this is additional proof that the high land was along the watershed.

Again, the courses of the scratches in western New York and on Lake Huron and Lake Nipissing (northeast of Lake Huron and south of Lake Temiscamang), have considerable *westing*. On the north shore of Lake Huron the course is mostly S. 13°–22° W., according to Logan; on the Georgian Bay (northeastern side of Lake Huron), S. 37°–45° W.; at the southeast bay of Lake Nipissing, S. 35° W; in western New York, S. 35° W., according to Hall. This prevalent *westing* points toward the same region northeast of Lake Temiscamang along the Canadian watershed, and seems to shut off from consideration regions farther north or west.

Taking into view all the observations here cited, we may conclude with much confidence that the region of greatest elevation along the watershed, or that of the Icy Plateau, was situated between Lake Temiscamang and Lake Mistissinny; and that its trend was consequently northeast and southwest, this being nearly that of the watershed between the lakes—a trend just right for a southeast movement of the ice.

Over the higher parts of the Green Mountains, *south* of Vermont, the amount of easting in the scratches diminishes southward, their direction being S. 40°–45° E. in northeastern Massachusetts; about S. 30° E. in southeastern Massachusetts; and about S. 25° E. in Connecticut and in eastern New York adjoining. These directions correspond well with the position assigned to the Icy Plateau. But as the Adirondacks lie between the two, it is not possible to say how far the courses may have been dependent upon these New York mountains.

2. *Height of the Icy Plateau above the sea.*—The higher summits of the Green Mountains are, according to Guyot, between 3800 and 4430 feet in elevation, the latter being the height of Mt. Mansfield. Killington Peak, 60 miles south of Mt. Mansfield and east of Rutland, is 4221 feet high (Guyot). The average height of the range, according to the same authority, is

about 3500 feet. The distance from Mt. Mansfield to southeastern Massachusetts is about 200 miles. The scratches of this mountain point southeastward toward the upper Merrimack valley; and those of this valley and of the adjoining region, down this valley in the direction of Boston Bay; and to this bay the distance from the summit of Mt. Mansfield is but 175 miles. Still, taking 200 miles as the length of the old glacier from Mt. Mansfield to the sea, and 3500 feet as the average height of the Green Mountains in Vermont, *the average rate of descent in the land is* 17½ *feet a mile*, and 20 feet a mile from the summits of the higher peaks. This was consequently the amount of slope that contributed toward the movement of the glacier over a large part of New England.

To have moved the same glacier from the northwestward *across the Green Mountains*, and to have abraded their highest summits and also scored surfaces on the White Mountains that are full 5200 feet above the sea, the propelling slope, or those of the Icy Plateau, must have certainly been higher than 5200 feet. We cannot assume that the rate of descent from the top of the Icy Plateau to the 5200 foot level on the White Mountains, a distance of about 400 miles, was as great as seventeen feet a mile; but we may reasonably infer it to have been at least *three* feet. This rate for 400 miles would make the height of the Plateau to average 6400 feet. The watershed is now about 1500 feet above the sea; accordingly, the average height of this region should have been at least 4900 feet greater than now.

A grade of *two feet* a mile would diminish this estimate 400 feet, making the required average height of the Icy Plateau 6000 feet.

The facts, therefore, demonstrate that this Canadian watershed was greatly higher—at least 4500 feet on an average—than at present. It is not supposed, or supposable, that the region was the course of a range of crested mountains that have since been washed away. No facts connected with glacial denudation, or that of subsequent time, favors such an extravagant assumption. All that the case demands is simply a bending upward of the surface over a wide area through a general continental movement of the crust having its greatest results to the north; and such we may believe it to have been. Similar oscillations of surface upward, and again downward, have taken place through all geological time, and they are still in progress; and geologists have detected them on some sea-shores where there is a standard water-level for comparison.

Moreover, the work of lifting continents and raising mountain chains went forward on a stupendous scale over Europe, Asia, and both Americas, through the whole era of the Tertiary; and this later upward movement in the higher latitudes of the continent followed on as the close of the long series, all

the preceding elevations, as well as the last, being in preparation for the Glacial era.

Such an *upward* bending is no more improbable than the *downward* bending which the Iceberg theory of the drift assumes to have taken place; and even less so, *since* the latter must have been greater in *vertical change* of level, and also vastly wider in its limits from north to south; and moreover such an event would have been out of joint with the times, tending to ameliorate instead of giving arctic vigor to the climate. And further, as I pointed out many years since, (this Journal, II, vii, 379, 1849,) there is independent proof of a high-latitude elevation of the continent during the Glacial era, in the fact that the drift latitudes are also *fiord* latitudes,—the fiords occupying valleys of erosion by fresh water or ice, which could have been made only when the land was far above the present level.

A bulging of the crust in any region to a height of 4,500 or 5,000 feet above its present level would have carried up the part of the continent adjoining to a greater or less extent. If the above use of fiords is right, they may help us, wherever they occur, in arriving approximately at the amount of elevation in the Glacial era along sea borders. From the depth of those of Maine,—mostly 100 to 150 feet--we thus learn that the land along this coast was at least 150 feet higher than now, and probably 200 feet. Other facts lead us to believe, as stated by the writer in his paper on the Geology of the New Haven region, (Mem. Acad. Conn. ii, p. 45,) that southern New England was 100 to 150 feet above its present level. Hence, the coast line of New England would have been much extended outward by the change of level. Long Island Sound would have been reduced to a narrow channel, and Long Island joined to Connecticut, to which it geographically belongs. St. Lawrence Bay would have been greatly contracted, and the St. Lawrence River lengthened seaward over part of its present site. Lake Champlain would have poured its waters down the valley of the Hudson; and, as others have shown, Lake Michigan down the Mississippi valley.

The elevation of New England would have increased in amount from the southern shore northward, and from the southeastern northwestward, toward the Icy Plateau. Consequently the White Mountains, Mt. Mansfield and other Green Mountain peaks, and the Adirondacks of northern New York, would probably have stood at least 500 feet above their present level. If so, it is necessary, in order to have the slope of one averaging two or three feet in a mile, that as much at least should be added to the average height of the great northern Icy Plateau, which would make it 6,500 to 7,000 feet.

If the Icy Plateau, instead of being along the watershed, was situated to the north and northwest of it, somewhere in

central or northern North America, the height must have been greater in proportion to the remoteness.

3. *The movement of the Glacier.*—The great glacier moved southeastward (the Icy Plateau trending northeastward) down the valley of the Ottawa and the slopes east of it, and marked its course deeply in the subjacent rocks. But on nearing the St. Lawrence, the lower part of its mass yielded to the impulse of gravity according with the slopes of this transverse valley, so that along this valley only *southwest* scratches were made, as facts show. Yet, the upper part of its mass continued on its first course, and, in northern New York and Vermont, and over southern Canada adjoining the latter State, the southeastward moving ice again touched bottom and resumed its work of abrasion. This is precisely parallel to what happened to the glacier, as I have shown, in its passage across the Connecticut River valley. In each case the valley determined the movement along its course of an under portion of the glacier, while the upper portion, spanning the valley, continued the grander movement initiated in the Icy Plateau, and favored by the general slope of New England. The great glacier, 6,000 to 8,000 feet in thickness, had no difficulty in keeping on its course according to the general slope of the land, and, at the same time, in following underneath the larger valleys or even many of the local slopes. It could not do otherwise. Icebergs in a continental sea, on the contrary, would have been puzzled to find all the criss-cross currents needed to help them along the valleys, up hill and down, and through all points of the compass.

4. *One cause of the cold of the Glacial era in North America.*—Increase in the extent and height of high-latitude lands may well stand as one cause of the cold of the American Glacial era. This rising of the land of northern Canada into a great plateau, at least as high as the summit of Mt. Washington, with the less elevation of wide regions north and south as a part of the great swell of the surface, and with the simultaneous elevation of other, perhaps higher, plateaus over the more northern and northwestern portions of the continent, and all a sequel to the majestic uplifts of the Tertiary, would have made a *Glacial* period for North America, whatever the position of the ecliptic, or whatever the eccentricity of the earth's orbit, though more readily of course if other circumstances favored. Having the most elevated land of eastern North America along the region pointed out, the courses of the winds and the distribution of moisture would have been different from the present. Canada being then on the *seaward* slope of the high land instead of, as now, on the landward slope, could not have had its comparatively dry climate with only an annual fall of 30 inches of moisture.

5. *Epochs of the Quaternary in North America.*—In view of the facts with regard to the elevated northern lands of the Glacial era here set forth—facts if Glaciers had anything to do with the Glacial phenomena—the epochs of the Quaternary, before deduced by the writer, come out in great boldness.

The movement of the GLACIAL era carried the northern lands upward, at least 5,000 feet above their present level in northern Canada, and probably as much or more over the higher latitudes to the west and north.

Then followed a slowly progressing subsidence—the great characteristic of the CHAMPLAIN era—which ultimately sank the same lands even to a greater extent than they had been raised, placing the valley of the St. Lawrence, about Montreal, over 500 feet below its present level, and probably 1,000 feet at least below its level in the Glacial era. With the commencement of this movement, or as it progressed, began the melting of the glacier; but the era continued, as proved by elevated beaches full of shells and other deposits, long after the melting ceased. During it, owing to the larger amount of subsidence to the north, north and south rivers had their slope greatly diminished, and in some places leveled out entirely for long distances; and owing to the vast depositions of drift, rivers, like Niagara, sometimes had their channels obstructed and were forced to begin new cuts, while other water-courses of the Glacial era were wholly cut off, as that from the Champlain Lake down the Hudson valley.

Afterward the return movement, that of the TERRACE era followed, placing the land finally at its present level, leading thus to a deepening of river channels, and thereby to the making of the river and lake terraces that cover the continent.

The fact of these grander movements which mark the three eras does not preclude the possibility of minor local oscillations of level during their progress.

ART. XLI.—*Variations in the Temperature of the Human Body;* by B. F. CRAIG, M.D. (Read before the Phil. Soc. of Washington).

IT is well understood that the temperature of the human body is kept approximately uniform under very various external conditions by a system of physiological compensations, and at the same time, it is not doubted that a certain amount of warming and of chilling does take place in spite of those compensations.

In disease, we have *occasionally* depressions of the temperature below the normal standard of 98.°4 Fah., and *frequently* considerable elevations above it—a rise of 2°, 4°, or even 6°

Fah., accompanying ordinary febrile disturbances. The peculiarity attending the rise of temperature in disease is that it is not much felt by the patient himself. In mild intermittent fever and in tubercular consumption, the heat of the body will often be found 1½° or 2° above the standard of health, while no sense of unusual heat, and sometimes no bodily discomfort of any kind, is felt by the sick man. Even in the more serious fevers, where the temperature goes up to 102°, 104°, or higher, there is not always a sense of increased heat proportioned to the disturbance of temperature: and moreover, the state of the temperature is governed mainly by the severity of the disease, and not by such external circumstances as the heat of the weather and the amount of clothing.

The great and long continued heat of the summer of 1870 gave me an opportunity, which seems unlikely to recur during the present summer, of investigating on myself to what extent the temperature of the healthy body was liable to rise under the influence of oppressively warm weather.

In the course of my experiments the highest temperature that I found was that of 99°·7 Fah. At this temperature I felt quite unpleasantly overheated, but not as much so as I would have been if instead of spending the morning indoors, I had been exposed to the rays of the sun in the open air. When the temperature of my body was below 99° I never felt uncomfortably hot. In fact, I satisfied myself by repeated trials, that a temperature of 99°·2 must be reached before the sensation of suffering from heat comes on.

During the hottest weather, I was able, by the prolonged use of the shower bath, to reduce my temperature to 97°·7. If, while at or about this temperature, I went into the street in the middle of a very hot day, the greatness of the heat was plainly felt as a sensation, but not as a cause of discomfort, as a man in cool weather might feel the glow of a furnace near which he was standing without being distressed by it. In fact, until my temperature had risen to 99°, I merely *perceived* how hot it was without being troubled by it.

It would thus appear that the discomfort we feel in hot weather is not from the impression of heat on the surface, but from the secondary effect of the heating up of the whole body; or rather, it is only when the heat of the whole body has risen nearly 1° Fah. that a check of the surface cooling begins to be unpleasant.

Very great elevations of temperature have been observed in sun stroke or heat apoplexy. That in all such cases the heat of the body rises above 100° Fah. before alarming symptoms manifest themselves, I think highly probable. Accurate thermometric examinations of mild cases of sun stroke and of per-

sons supposed to be on the verge of apoplexy from excessive heat, may be pointed out as scientific desiderata.

In the Philos. Trans. for 1792 are to be found some curious experiments by Dr. James Currie, on the cooling of the human body by cold baths. He carried the reduction of temperature as low as 88° Fah., and this seemed, from the symptoms produced, to be as far as the heat of the body could be reduced with safety. It is to be hoped that some one may supplement these researches by experiments in the direction of the elevation of the animal temperature.

ART. XLII.—*Preliminary Catalogue of the bright lines in the Spectrum of the Chromosphere;* by C. A. YOUNG, Ph.D., Professor of Astronomy in Dartmouth College.

The following list contains the bright lines which have been observed by the writer in the spectrum of the chromosphere within the past four weeks. It includes, however, only those which have been seen twice at least; a number observed on one occasion (Sept. 7th) still await verification.

The spectroscope employed is the same described in the Journal of the Franklin Institute for November, 1870; but certain important modifications have since been effected in the instrument. The telescope and collimator have each a focal length of nearly 10 inches, and an aperture of $\frac{3}{4}$ of an inch. The prism-train consists of five prisms (with refracting angles of 55°) and two half-prisms. The light is sent twice through the whole series by means of a prism of total reflection at the end of the train, so that the dispersive power is that of twelve prisms. The instrument distinctly divides the strong iron line at 1961 of Kirchhoff's scale, and separates B (not b) into its three components. Of course it easily shows everything that appears on the spectrum maps of Kirchhoff and Angstrom. The adjustment for "the position of minimum deviation" is automatic; i. e., the different portions of the spectrum are brought to the center of the field of view by a movement which at the same time also adjusts the prisms.

The telescope to which the spectroscope is attached is the new Equatoreal recently mounted in the observatory of the College by Alvan Clark & Sons.

It is a very perfect specimen of the admirable optical workmanship of this celebrated firm, and has an aperture of $9\frac{4}{10}$ inches, with a focal length of 12 feet.

In the table the first column contains simply the reference number. An asterisk denotes that the line affected by it has no well marked corresponding dark line in the ordinary solar spectrum.

Preliminary Catalogue of Chromospheric Lines.

Ref. No.	Kirchhoff.	Angstrom.	Rel. Frequency	Rel. Brightn'ss.	Chemical Element.	Previous Observer.
*1	534·5	7060·?	60	3		
2	654·5	6677·?	8	4		L.
3	C	6561·8	100	100	H.	L. J.
4	719·0	6495·7	2	2	Ba.	
5	734·0	6454·5	2	3		
6	743·?	6431·	2	2		
7	768·?	6370·	2	2		
8	816·8	6260·3	1	1	Ti.	
9	820·0	6253·2	1	2	Fe.	
10	874·2	6140·5	6	8	Ba.	L.
11	D_1	5894·8	10	10	Na.	L.
12	D_2	5889·0	10	10	Na.	L.
*13	1017·0	5871·	100	75		L. J.
14	1274·3	5534·0	6	8	Ba.	R. L.
15	1281·5	5526·0	1	1	Fe.	
16	1343·5	5454·5	1	2	Fe.	
17	1351·3	5445·9	1	2	Fe. Ti.	
18	1363·1	5433·0	1	1	Fe.	
*19	1366·0	5430·0	2	3		
20	1372·0	5424·5	3	4	Ba.	L.
21	1378·5?	5418·0?	1	2	Ti.?	
*22	1382·5	5412·	1	1		
23	1391·2	5403·0	2	2	Fe, Ti.	
24	1397·8	5396·2	1	2	Fe.	
25	1421·5	5370·4	1	2	Fe.	R.
26	1431·3	5360·6	2	2		R.?
27	1454·7	5332·0	2	2	Ti.	
28	1462·9	5327·7	1	3	Fe.	
29	1463·4	5327·2	1	3	Fe.	
30	1465·0?	5321·	2	2		
31	Cor'na line 1474·1	5315·9	75	15	Fe?	L.
32	1505·5	5283·	5	4		
33	1515·5	5275·0	7	5		L. R.
34	E_1	5269·5	1	3	Fe, Ca.	
35	E_2	5268·5	1	2	Fe.	
36	1528·0	5265·5	3	2	Fe. Co.	L.
37	1561·0	5239·0	1	1	Fe.	
38	1564·1	5236·2	1	1		
39	1567·7	5233·5	2	2	Mn.	R.
40	1569·7	5232·0	1	2	Fe.	
41	1577·3	5226·0	1	2	Fe.	
42	1580·5?	5224·5	1	1	Ti.	
43	1601·5	5207·3	3	3	Cr, Fe.?	
44	1604·4	5205·3	3	3	Cr.	
45	1606.5	5203·7	3	3	Cr, Fe.?	
46	1609·3	5201·6	1	2	Fe.	
47	1611·5	5199·5	1	1		
48	1615·6	5197·0	3	2		L. R.
49	b_1	5183·0	15	15	Mg.	L.
50	b_2	5172·0	15	15	Mg.	L.
51	b_3	5168·5	12	10	Ni.	L.
52	b_4	5166.5	10	10	Mg.	L.
53	1673 9	5153·2	1	1	Na.	
54	1678·0	5150·1	1	2	Fe.	
55	1778·5	5077·8	1	1	Fe.	
56	1866·8	5017·5	2	3		R.
57	1870·3	5015·?	2	2		R.
58	1989·5	4933·4	8	5	Ba.	L.
59	2001·5	4923·2	5	3	Fe.	R. L.
60	2003·2	4921·3	1	1		
61	2007·1	4918·1	3	3		L.
62	2031·0	4899.3	6	4	Ba.	L.
63	2051·5	4882·5	2	2		L.
64	F.	4860·6	100	75	H.	J. L.
65	2358·5	4629·0	1	1	Ti.	
66	2419·3	4583·5	1	1		
67	2435·5	4571·4	1	1	Li.	
68	2444·0	4564 6	1	1		
69	2446·6	4563·1	1	2	Ti.	
70	2457·8	4555·0	1	1	Ti.	
71	2461·2	4553·3	3	3	Ba.	
72	2467·7	4548·7	1	3	Ti.	
73	2486·8	4535·2	1	1	Ti. Ca.?	
74	2489·5	4533·2	1	1	Fe.	
75	2490·6	4531·7	1	1	Ti.	
76	2502·5	4524·2	2	2	Ba.	
77	2505·8	4522·1	1	2	Ti.	
78	2537·3	4500·4	1	3	Ti.	
79	2553·?	4491·0?	1	1	Mn.?	
80	2555·?	4489·5?	1	1	Mn.?	
81	2566·5	4480·4	1	2	Mg.	L.
82	2581·5?	4471·4	75	8	A band rather than a line.	
83	2585·5	4468·6	1	1	Ti.	
84	2625·0	4443·0	1	1	Ti.	
85	2670·0	4414·6	1	1	Fe, Mn.	
86	2686·7	4404·3	1	2	Fe.	
87	2705·0	4393·5	3	2	Ti.	
88	2719·?	4384·8	1	1	Ca.?	
89	2721·2	4382·7	1	2	Fe.	
90	2734·?	4372·	1	1		
91	2737·?	4369·3?	1	1	Cr.?	
92	2775·8	4352·0	1	1	Fe. Cr.	
93	2796·0	4340·0	100	50	H.	L. J.
94	G.	4307·0	1	2	Fe. Ti. Ca.	
95	2770·0	4300·0	1	1	Ti.	
96		4297·5	1	1	Ti, Ca.	
97		4289·0	1	2	Cr.	
98		4274·5	1	2	Cr.	
99		4260·0	1	1	Fe.	
100		4245·2	1	1	Fe.	
101		4226·5	1	1	Ca.	
102		4215·5	1	2	Fe. Ca.	
103	*h.*	4101·2	100	20	H.	R. L.

The second column gives the position of the line upon the scale of Kirchhoff's map—determined by direct comparison with the map at the time of observation. In some cases an interrogation mark is appended, which signifies not that the *existence* of the line is doubtful, but only that its precise place could not be determined, either because it fell in a shading of fine lines, or because it could not be decided in the case of some close double lines which of the two components was the bright one; or finally because there were no well marked dark lines near enough to furnish the basis of reference for a perfectly accurate determination.

The third column gives the position of the line upon Angstrom's normal atlas of the solar spectrum. In this column an occasional interrogation mark denotes that there is some doubt as to the precise point of Angstrom's scale corresponding to Kirchhoff's. There is considerable difference between the two maps, owing to the omission of many faint lines by Angstrom, and the want of the fine gradations of shading observed by Kirchhoff, which renders the coördination of the two scales sometimes difficult, and makes the atlas of Kirchhoff far superior to the other for use in the observatory.

The numbers in the fourth column are intended to denote the percentage of frequency with which the corresponding lines are visible in my instrument. They are to be regarded as only roughly approximative; it would of course require a much longer period of observation to furnish results of this kind worthy of much confidence.

In the fifth column the numbers denote the relative brilliance of the lines on a scale where 100 is the brightest and 1 the faintest. These numbers also, like those in the preceding column, are entitled to very little weight.

The sixth column contains the symbols of the chemical substances to which, according to the maps above referred to, the lines owe their origin.

There are no disagreements between the two authorities; in a majority of cases, however, Angstrom alone indicates the element, and there are several instances where the lines of more than one substance coincide with each other and with a line of the solar spectrum so closely as to make it impossible to decide between them.

In the seventh and last column the letters J., L. and R. denote that to my knowledge the line indicated has been observed and its place published by Janssen, Lockyer or Rayet. It is altogether probable that a large portion of the other lines contained in the catalogue have before this been seen and located by one or the other of these keen and active observers, but if so I have as yet seen no account of such determinations.

I would call especial attention to the lines numbered 1 and 82 in the catalogue: they are very persistently present, though faint, and can be distinctly seen in the spectroscope to belong to the chromosphere as such, not being due, like most of the other lines, to the exceptional elevation of matter to heights where it does not properly belong. It would seem very probable that both these lines are due to the same substance which causes the D^3 line.

I do not know that the presence of *Titanium vapor* in the prominences and chromosphere has before been ascertained. It comes out very clearly from the catalogue, as no less than 20 of the whole 103 lines are due to this metal.

Hanover, N. H., Sept. 13, 1871.

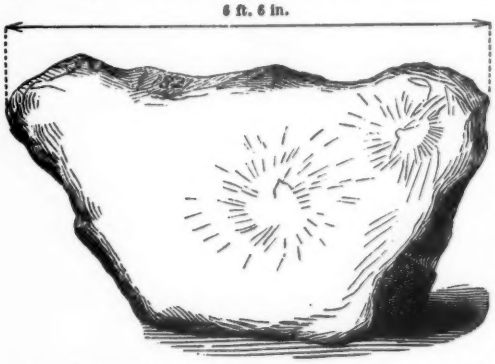
ART. XLIII.—*The precise Geographical position of the large masses of meteoric iron in North Mexico, with the description of a new mass—The San-Gregorio Meteorite;* by J. LAWRENCE SMITH, Louisville, Ky.

SOME of the remarkable masses of meteoric iron in Northern Mexico have been known to travelers for a number of years; but no very precise information concerning them had been given until the year 1854, when the first mass, brought from that locality, was placed at my disposal by Lieut. Gouch of the U. S. Army, and was described in a memoir on meteorites published in the American Journal of Science, April, 1854; it is now in the Smithsonian Museum, and weighs 252 lbs.

On the return of Mr. Bartlett, of the Boundary Commission, I learned of two other masses in that region, and Lieut. John G. Parke, of the U. S. Army, placed a fragment of one of them in my possession; the fragment of the other mass was lost. I figured and described both of those meteorites in the memoir just alluded to; the first, which I called the *Tucson Meteorite*, is now in the Smithsonian Institute, and weighs, I believe, several thousand pounds; the second one I called the *Chihuahua iron*, and is still at the *Hacienda de Conception*, where it was first found. Still later in the year 1868, Dr. H. B. Butcher placed under my examination eight masses of meteoric iron that had been brought to the United States from the same region of Mexico; these I examined, and published a full account of in the American Journal of Science. These masses are now in Philadelphia, still owned by Dr. Butcher, and vary in weight from about 300 lbs. to 800 lbs. Dr. Butcher having returned to Mexico, I requested him to get all possible information in regard to the geographical position of these bodies; this he

has succeeded in accomplishing. At the same time he has a fragment of another mass, still larger than any yet known, which will be called the *San-Gregorio Meteoric Iron.* Its description is as follows:

The San-Gregorio Meteorite.—This immense mass of meteoric iron is situated on the western border of the Mexican Desert, a map of which is given on the next page. Some idea of its form may be had in the accompanying sketch.



It measures 6 feet 6 inches in its greatest length, is 5 feet 6 inches high, and 4 feet thick at its base; on one part of its surface, 1821 is cut with a chisel, and above this date is the following inscription: "*Solo dios con un poder este fierro destruerá, por que en el mondo no habra quien lo puedo deschacer.*"

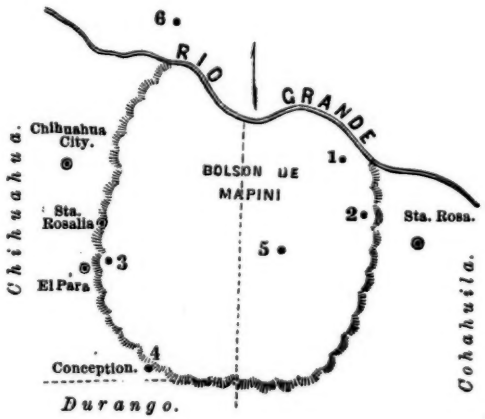
It lies within the enclosure of a hacienda, having been hauled to the ranch many years ago by the Spaniards, who thought that it could be made use of as iron for farming utensils. It is said to have fallen quite near its present site, and from its huge bulk and weight, which is calculated to be about five tons, it could not have been transported very far. Nothing more is known of its history. Small specimens were detached by Dr. Butcher, one of which I have examined. I find it to be of the softer meteoric irons, with a specific gravity of 7·84. The fragment I possess is too small for the study of the true character of its Widmannstätian figures.

On analysis, it furnished the following composition:

Iron,	95·01
Nickel,	4·22
Cobalt,	·51
Copper,	minute trace
Phosphorus,	0·08

This *San-Gregorio* iron makes the fifth that has come under my observation and examination from this famous Mexican locality, the geography of which I will now describe, referring to the accompanying diagram for details.

The Bolson de Mapini or Mexican Desert occupies the western portion of the province of Cohahuila, and the eastern portion of the province of Chihuahua. It is 400 miles from east to west, and 500 miles from north to south, bounded on the north by the river Rio Grande. Some of the villages and haciendas are specified in the diagram, and the numbers 1, 2, 3, &c., are the localities of the different meteoric masses discovered.



No. 1. The locality of the *Cohahuila* meteorite described by me in this Journal, April, 1854; it is now in the Smithsonian Institution.

No. 2. The locality of the *Cohahuila* meteorite of 1868, described by me in this Journal, April, 1870; it is now in the possession of Dr. Butcher.

No. 3. The locality of the *San-Gregorio* meteorite just described; it is still in the place where it was first observed.

No. 4. The locality of the mass described and figured in my memoir on meteorites (this Journal, April, 1854), and called the *Chihuahua Meteorite;* it is still in place at the *Hacienda de Conception*, 10 miles from Zapata, its greatest height being forty-six inches, breadth thirty-seven, and in the thickest part eight feet three inches in circumference. Signor Urquida calculated its weight to be about four thousand pounds.

No. 5. The locality of a huge meteorite lately discovered, of which no specimen has yet been detached, and is said to be larger than any one yet found in that locality.

No. 6. The locality of the large mass described and figured by me in 1854 as the *Tucson iron*, and now in the Smithsonian Institution at Washington, having a large hole in the center, and

sometimes called the *Signet Meteorite*, also the *Ainsa Meteorite*. I do not know its exact weight, but suppose that it must weigh two or three thousand pounds.

The question naturally arises, what can be the cause of the number of meteoric masses in the circumscribed region, and whether each one represents a separate fall? My study of them leads me to the belief that they are the products of two falls. First of all, No. 6, the Signet or Ainsa meteorite, has peculiar physical and chemical characters that separate it entirely from the others. Nos. 1, 2 and 3 I have examined chemically, and find them very closely allied in composition, also in physical properties, as the softness of the iron and freedom from rusty crusts over the exterior; in fact the pieces I have examined were more or less bright on the exterior surface. The Widmannstätien figures I have not had an opportunity to compare, since, with the exception of No. 1, I have had only small pieces that were detached from the surface by a cold chisel, which are unfit for the study of these figures. Thus far in my investigation, there appears strong reasons for supposing that at some epoch, probably far remote, the meteoric masses 1, 2, 3, 4 and 5 were the products of the fall of one meteoric mass, moving from the northeast to the southwest, the smaller masses falling first at 1 and 2, and the larger masses farther on. The distances of these bodies from each other are, from Nos. 1 to 2 about 85 miles, from 2 to 5 about 135 miles, from 5 to 3 about 165 miles, from 3 to 4 about 90 miles. Of course these is no great stress laid upon these deductions, but it would not be surprising if further investigation should sustain this view.

Since my first publication on these meteorites, Burckhardt, of Bonn, has made some observations upon them, but his publications are not within my reach at the present time.

ART. XLIV.—*On the Iridium compounds analagous to the Ethylen and Protochloride of Platinum Salts*;* by Prof. SAMUEL P. SADTLER, Ph.D., Pennsylvania College, Gettysburg, Pa.

AMONG the compounds which we are accustomed to call *organo-metallic*, those of $PtCl_4$ and $PtCl_2$ play perhaps the most important part. We can separate them, however, into the two great classes—those where the $PtCl_4$ and $PtCl_2$ enter by substitution into compound ammonia-atoms, and thus form bases more or less complex, but having still a certain connection; and those where the $PtCl_4$ and $PtCl_2$ take up organic radicals of different degrees of valence to form saturated compounds.

* Extract from an Inaugural dissertation at the Univ. of Göttingen, April, 1871.

The range of this last class, as can be seen, is very wide; one of the most prominent of these compounds, however, and one which exercised for some time a very considerable influence upon the theoretical views held at that time, is the compound of $PtCl_2$, known as Zeise's salt, and discovered and investigated by him in 1830.

It is not necessary to recount here the controversy which took place between Zeise and Liebig on the subject. Suffice it to say that, by subsequent investigations of Griess and Martius and of Birnbaum, its formula is definitely settled as $PtCl_4$, C_2H_4+KCl.

The investigation I now undertook was to see if a similar base of iridium could be prepared. Various considerations, stated at length in my original paper, led me to believe that iridium might not combine exactly as platinum did, in the formation of these salts.

After obtaining the double chloride of iridium and ammonium in the usual way, by decomposing the osmiridium, I made some tests as to the manner of formation of the salt. An attempt to form it by taking the double chloride of iridium and ammonium in solution, and, passing a stream of chlorine through to break up the chloride of ammonium, to then conduct ethylen gas into it, was unsuccessful. The method which succeeded most perfectly was to act upon iridium chloride. This was obtained by igniting the double chloride of iridium and ammonium, thus obtaining iridium oxide and metallic iridium, which was then heated with aqua regia in sealed tubes of bohemian glass to 180° or 200°C. This solution of $IrCl_4$, I then treated with absolute alcohol. On adding KCl, and allowing it to crystallize out, I got the greenish-brown crystals of the iridium-ethylen base. On subjecting them to an organic combustion, I obtained as products carbonic acid and water. They burned with a luminous flame, and answered, in short, all the tests applied to Zeise's platinum salt.

Another experiment, to see if ethylen gas would act directly upon the $IrCl_4$, reducing it and uniting at the same time, was unsuccessful.

It will thus be seen, that the only method of preparing the iridium-base is by the reducing action of alcohol on iridium chloride, according to the reaction:—

$$IrCl_2\ Cl_2+\begin{matrix}CH_3\\|\\CH_2OH\end{matrix}+\begin{matrix}CH_2\\|\\CH_2\end{matrix}\Big|\begin{matrix}H\\OH\end{matrix}=IrCl_2,C_2H_4+2HCl+\begin{matrix}CH_3\\|\\COH\end{matrix}+H_2O$$

the products of which are iridium-ethylen-protochloride, hydrochloric acid, aldehyde and water.

The purifying of the necessary iridium was found to be a very long and tedious operation, the last traces of platinum

sticking very pertinaciously to the iridium salt. The processes in use also leave much to be desired in the way of completeness and expedition.

The method selected for separation was the method of Birnbaum, grounded upon the distinct and separate crystallization of the double cyanides of iridium and barium and platinum and barium. To convert the double chlorides of iridium and ammonium, and platinum and ammonium into the double cyanides of iridium and potassium, and platinum and potassium, after trying Wöhler's and Muckle's method and obtaining unsatisfactory results, I had recourse to Martius' method. This consists in mixing the dry impure chloride of iridium and ammonium with powdered cyanide of potassium, and fusing and then taking up with water the fused mass. After working some time with this method, with rather poor results, owing to the high heat required to bring the mass to fusion and the invariable decomposition of the newly formed double cyanides, resulting from the application of such a heat, I modified the method in several particulars. I found, on trying, that the black iridium oxide went very readily into solution in the fused cyanide of potassium. Taking, therefore, the double chloride of iridium and ammonium and igniting it to transform it into the iridium oxide, I proceeded after the following manner. Covering the bottom of the crucible with a bed of powdered KCy, I then added a mixture of KCy and iridium oxide, and exposed it to the flame of the blast-lamp. The fusing cyanide takes up quite readily the metallic oxide, and is soon in calm fusion. A reduction still takes place, but by no means to the extent experienced before. This is occasioned by the strong heat which has to be applied to get the mass into full fusion. Another modification which I then made has some advantages over this just described. It is to bring a few pieces of KCy to full fusion, and then keeping it so, to add a previously prepared mixture of the iridium oxide and finely pulverized cyanide of potassium to it, in small quantities at a time. The advantage here is, that, when the KCy has once been brought to fusion, it can be kept there with a comparatively small flame, and the reduction of the double cyanides does not occur so readily. It is true, that adding the iridium so slowly, the compound is kept in the fused state longer. My experience, however, leads me to prefer this latter plan, and I generally used it as giving the largest yield. Birnbaum's method proper is now used. The solution of the double cyanides, filtered off from any unattacked iridium oxide, contains a tolerably large excess of free KCy. This is destroyed by adding dilute HCl. When neutral, a concentrated solution of copper vitriol is added. The violet-colored precipitate of mixed double cyanides of iridium and platinum with copper is

washed by decantation with boiling water. While suspended therein, a strong solution of caustic baryta is added. The copper is thrown down as brown oxide of copper, and the double cyanides of iridium and platinum with barium are formed, which remain in solution. When the fluid reacts distinctly alkaline, after a minute or so boiling, it is filtered off, and then CO_2 is passed through, until a neutral reaction is obtained. Filter off the precipitate of $BaCO_3$, and then concentrate for crystallization. The yellow platinum salt crystallizes out first in small crystals, with a play of colors from yellow to blue, being similar in their dichroic effects to most of the other double cyanides of platinum. The iridium salt crystallizes then in larger colorless prisms, which can be easily separated mechanically from the platinum crystals. The iridium crystals I ignited in a porcelain crucible, and having thus completely broken up the compound, drew out the baryta with boiling water. The iridium, after being well washed and ignited to completely oxidize it, was heated as before with aqua regia in a sealed tube to 200°C. The $IrCl_4$ solution obtained was again treated with absolute alcohol, and, on addition of KCl and NH_4Cl, the crystallized salts were obtained.

However the compounds which were now formed were, contrary to my expectations, not the ethylen salts pure and alone, but there was a simultaneous formation of what appear to be several distinct compounds. Although in one preparation of ammonium salt analyzed, the ethylen-protochloride-salt was isolated tolerably pure, yet, in the majority of the analyses, I had to do with a mixture difficult to separate even under the lens. The readiness with which these compounds decompose when subjected to recrystallization, even although one observes the precaution of keeping the solution distinctly acid, prevents any successful purifying that way. The preparation, therefore, had to be prepared for analysis by drying between bibulous paper, and then over H_2SO_4 or at 100°, according as I wished to determine the percentage of water or not. A certain amount of HCl from the acid solutions therefore, adhering to the crystals, made the Cl determinations as a rule high. Still the results approximate sufficiently, these circumstances being taken into consideration, to the formulas given, to show that several distinct compounds are here formed. My first crystallization consisted of brownish-red octahedra, which when analyzed gave in three Cl determinations 42·13 pr. ct., 42·07 pr. ct. and 42·09 pr. ct. Cl, showing them to be simple $IrCl_4(KCl)_2$, of which the percentage of Cl is 42·08 pr. ct.

I next got a crystallization of fine, sharply-formed monoclinic crystals of a reddish-brown color, which I think the analyses, although not perfectly conclusive, still go to show to be a new

compound. Several different crystallizations of it were analysed. It could not always be entirely separated from the slight crust of decomposed KCl which separated out along with and among the crystals.

Preparation No 1. Large well-formed crystals, with but very little foreign matter adhering to the sides.

·1567 grms. dried over H_2SO_4 lost by heating to 100° ·0170 grms. = 10·85 pr. ct.:

gave ·0525 grms. metallic iridium = 33·50 pr. ct.:

gave also ·2275 grms. AgCl = ·0563 grms. Cl = 35·92 pr. ct.

·1610 grms. dried over H_2SO_4 lost by heating to 100° ·0172 grms. = 10·68 pr. ct.:

gave — Ir. determination accidentally spoiled:

gave also ·2320 grms. AgCl = ·0574 grms. Cl = 35·65 pr. ct.

This we see at once cannot be any chloride of iridium and potassium. Its luminous flame, too, when burned, shows the same. Nor do the percentages agree with the simple potassic-ethylen iridium protochloride $IrCl_2C_2H_4KCl+2H_2O$ where the Ir. = 48·45 pr. ct. and Cl = 26·19 pr. ct.

If we reckon out the ratio of iridium to chlorine, we find it as 1 : 6, showing it to be an iridium-chloride compound. The large pr. ct. of loss on heating, the small Ir. and Cl pr. cts., when compared with double iridium and potassic chloride, and the luminous flame when burned, all go to show that an organic constituent must make the additional pr. ct. If we suppose now ethylen to enter here into the union with iridium chloride, hanging itself on, we can expect from the consideration of analogous compounds that 2 atoms of the bivalent radical C_2H_4 would join the atom $PtCl_4$.

We would have on this supposition the formula $IrCl_4(C_2H_4)_2(KCl)_2 + \chi H_2O$. Now this formula with 3 atoms H_2O gives Ir. = 32·93 pr. ct., Cl = 35·61 pr. ct., and with 2 atoms H_2O, Ir. = 33·95 pr. ct., Cl = 36.71 pr. ct.; anhydrous it gives Ir. = 36·20 pr. ct. and Cl = 39·14 pr. ct.

The large pr. ct. of loss at 100° is not accounted for by $3H_2O$, which give only 9·03 pr. ct.; but it is possible that in a compound where the organic constituent is so loosely connected with the rest, as must be the case here, a partial decomposition of the salt enters at 100° already.

In another preparation, also well crystallized, ·1822 grms. dried at 100°:

gave ·0678 grms. metallic iridium = 37·21 pr. ct.;

gave also ·3063 grms. AgCl = ·0758 grms. Cl = 41·59 pr. ct.

In another preparation, indistinctly crystallized, ·0502 grms. dried at 100°:

gave ·0172 grms. metallic iridium = 34·26 pr. ct.

(Probably low from HCl mechanically admixed.)

In another preparation, also indistinctly crystallized, ·3207 grms. dried at 100°:

gave ·2125 grms. AgCl = ·1268 grms. Cl = 39·53 pr. ct.

It will thus be seen the determinations, all things considered, agree close enough with the theoretical pr. cts. of the formula to make it very probable. The want of enough sufficiently-well crystallized material prevented me from making an organic combustion which might settle it definitely.

Several individual crystals of the first crystallization were very sharply and clearly formed, and I subjected them to examination under the microscope with a power of about 50 diameters. The faces were clearly to be made out. They belong to the monoclinic system, and their prevailing habitus in crystallization is a combination of the two lateral pinacoids with positive and negative pyramids accompanied by one macrodome on the ends. The faces observed in an examination of five distinct crystals were (according to Naumann) $\infty P \infty$. $\infty P \breve{\infty}$ $+P$. $-P$. $+\frac{1}{2}P$. $-\frac{1}{2}P$. $+P\infty$. $-P\infty$.

In considering the compounds of the iridium-base with NH_4Cl, we find again a mixture of crystallized salts.

Preparation No. 1 consisted of sharply crystallized needles that looked almost black, and only by transmitted light showed a brownish-green color. They were also monoclinic.

On analysis they prove, I think, to be the sought-for ethylen-iridium compound.

·0713 grms. dried over H_2SO_4 lost on heating to 100° ·0029 = 4·07 pr. ct.:

gave ·0850 grms. AgCl = ·0210 grms. Cl = 29·49 pr. ct. or 30·74 pr. ct. of salt dried at 100°.

The iridium determination was made with magnesium, and was inaccurate as before.

The formula $IrCl_2C_2H_4NH_4Cl + H_2O = 367·5$ demands Cl = 28·98 pr. ct., $H_2O = 4·89$, or anhydrous 30·47 pr. ct. Cl.

Preparation No 2 was of much smaller needles and of lighter color.

Analyses show it to be of very similar composition to the potassium salt described above.

·1207 grms. dried at 100° C.:

gave ·0495 grms. metallic Ir. = 41·97 pr. ct.:

gave also ·2068 grms. AgCl = ·0512 grms. Cl = 43·37 pr. ct.

$IrCl_4(C_2H_4)_2(NH_4Cl)_2$ = ·502 gives Ir. = 39·25 pr. ct. and Cl = 42·43 pr. ct., and supposing it to lose some of the C_2H_4 at 100°, as stated above, $IrCl_4(C_2H_4)(NH_4Cl)_2$ would give Ir. = 41·50 pr. ct. and Cl = 44·94 pr. ct.

The other two preparations of the ammonium salt analysed appeared under the lens to be mixtures of the iridium proto-

chloride-ethylen salt and the iridium chloride-ethylen salt given above.

The results were—

·1322 grms. dried at 100°:

gave ·0609 grms. metallic iridium = 46·07 pr. ct.

·1715 grms. dried at 100°:

gave ·0784 grms. metallic iridium = 46·95 pr. ct.

$IrCl_2(C_2H_4)(NH_4Cl) + H_2O$ gives Ir. = 53·61 pr. ct.

$IrCl_4(C_2H_4)_2(NH_4Cl)_2$ gives Ir. = 39·25 pr. ct.

The existence of the base $IrCl_4(C_2H_4)_2$ I hope to settle definitely by renewed analyses of larger quantities.

While engaged with the preparation of the ethylen and iridium compound, the thought of the possibility of acetylen (C_2H_2) uniting with $PtCl_2$ or $IrCl_2$ led me to make some experiments in that direction. After a number of endeavors to form a platinum salt and analyses of the products (a detailed account of which is given in the original paper), I obtained negative results only. The existence of such a salt is highly improbable.

ART. XLV.—*Directions for Constructing Lightning-Rods.* From Essays on Meteorology; by Prof. JOSEPH HENRY.*

1st. The rod should consist of round iron, of not less than three-fourths of an inch in diameter. A larger size is preferable to a smaller one. (Ordinary gas pipe may be employed). Iron is preferred, because it can be readily procured, is cheap, a sufficiently good conductor, and, when of the size mentioned, cannot be melted by a discharge from the clouds. Other forms of rod, such as flat or twisted, will conduct the lightning, and in most cases answer sufficiently well. They tend, however, to give off lateral sparks from the sharp edges at the moment of the passage of the electricity through them, which might, in some cases, set fire to very combustible materials.

2d. It should be, through its whole length, in perfect metallic continuity; as many pieces should be joined together by welding as practicable, and, when other joinings are unavoidable, they should be made by screwing the parts firmly together by a coupling ferule, care being taken to make the upper connection of the latter with the rod water-tight by cement, solder, or paint.

3d. To secure it from rust, the rod should be covered with a coating of black paint.

* Smithsonian Miscellaneous Collections.

4th. It should be terminated above with a single point, the cone of which should not be too acute, and to preserve it from the weather, as well as to prevent its being melted, should be encased with platinum, formed by soldering a plate of this metal, not less than a twentieth of an inch in thickness, into the form of a hollow cone. Points of this kind can be purchased of almost any mathematical instrument maker. Usually the cone of platinum, for convenience, is first attached to a brass socket, which is secured on the top of the rod, and to this plan there is no objection. The platinum casing, however, is frequently made so thin, and the cone so slender, in order to save metal, that the point is melted by a powerful discharge.

5th. The shorter and more direct the rod is in its course to the earth the better. Acute angles, made by bending the rod, and projecting points along its course, should be avoided.

6th. It should be fastened to the house by iron eyes, and may be insulated by cylinders of glass. We do not think the latter, however, of much importance, since they soon become wet by water, and, in case of a heavy discharge, are burst asunder.

7th. The rod should be connected with the earth in the most perfect manner possible; and in cities nothing is better for this purpose than to unite it in good metallic contact with the gas-mains or large water-pipes in the streets; and, indeed, such a connection is absolutely necessary, if gas or water-pipes are within the house. Electricity, by what is called induction, acts at a distance on the perpendicular gas-pipes within a house, rendering them so highly negative, the cloud being positive, as to attract the electricity from a lightning-rod imperfectly connected with the earth, or even from the air through the roof. Damage to buildings on this account is of constant occurrence. The above connection can be made by soldering to the end of the rod a strip of copper, which, after being wrapped several times around the pipe, is permanently attached to it. Where a connection with the ground cannot be formed in the way mentioned, the rod should terminate, if possible, in a well, always containing water; and, where this arrangement is not practicable, it should terminate in a plate of iron or some other metal buried in the moist ground. It should, before it descends to the earth, be bent, so as to pass off nearly at right angles to the side of the house, and be buried in a trench, surrounded with powdered charcoal.

8th. The rod should be placed, in preference, on the west side of the house, in this latitude, and especially on the chimney from which a current of heated air ascends during the summer season.

9th. In case of a small house, a single rod may suffice, provided its point be sufficiently high above the roof; the rule

being observed, that its elevation should be at least half of the distance to which its protection is expected to extend. It is safer, however, particularly in modern houses, in which a large amount of iron enters into the construction, to make the distance between two rods less than this rule would indicate, rather than more. Indeed, we see no objection to an indefinite multiplication of rods to a house, provided they are all properly connected with the ground and with each other. A building entirely inclosed, as it were, in a case of iron rods so connected with the earth, would be safe from the direct action of the lightning.

10th. When a house is covered by a metallic roof, the latter should be united, in good metallic connection, with the lightning rods; and in this case the perpendicular pipes conveying the water from the gutters at the eaves may be made to act the part of rods, by soldering strips of copper to the metal roof and pipes above, and connecting them with the earth by plates of metal united by similar strips of copper to their lower ends: or, better, with the gas or water-pipes of the city. In this case, however, the chimneys would be unprotected, and copper lightning-rods, soldered to the roof and rising a few feet above the chimneys, would suffice to receive the discharge. We say soldered to the roof, because, if the contact was not very perfect, a greater intensity of action would take place at this point, and the metal might be burnt through by the discharge, particularly if it were thin.

11th. As a general rule, large masses of metal within the building, particularly those which have perpendicular elevation, ought to be connected with the rod. The main portion of the great building erected for the World's Exhibition at Paris was entirely surrounded by a rod of iron, from which rose at intervals a series of lightning-conductors, the whole system being connected with the earth by means of four wells, one at each corner of the edifice.

The foregoing rules may serve as general guides for the erection of lightning-rods on ordinary buildings, but for the protection of a large complex structure, consisting of several parts, a special survey should be made, and the best form of protection devised which the peculiar circumstances of the case will admit.

Art. XLVI.—*The Paragenesis and Derivation of Copper and its associates on Lake Superior;* by Raphael Pumpelly.

[Continued from pages 188 and 258.]

Chalcocite, Bornite, Whitneyite, Domeykite.—Two fissure-veins are known in the neighborhood of Portage Lake which carry these ores. They have been examined only very superficially; but it is a remarkable fact that the amygdaloids traversed by these veins contain only native copper. One of the fissure-veins, bearing both sulphides and arsenides of copper, enters the Grand Portage cupriferous amygdaloid bed, which bears only native copper, and remains in it with a changed direction for a short distance. The gangue of these veins is quartz, calcite and a carbonate of lime containing some iron and magnesia—ankerite?

The only other instance I have observed of the occurrence of copper in combination with sulphur, is in the fissure-vein of the Mendota property, near Lac la Belle. This vein appears to traverse the entire trappean series from Agate Harbor on the north to Lac la Belle.

Wherever this vein has been opened or uncovered, along the greater part of its course, north of the Mendota property, only *native* copper has been found; but when it enters a bed of conglomerate on the north flank of Mt. Bohemia, the little copper it contains is combined with sulphur in a very pure chalcocite. Where the vein passed from the conglomerate into the underlying amygdaloid, a fine deposit of chalcocite with calcite was found to have been formed, for a short distance, on both sides of the vein, between the two beds.

Still farther south the vein enters a mass of syenite, consisting of a pink triclinic feldspar, some hornblende and much chlorite, as an alteration-product of hornblende, and containing frequent impregnations of chalcopyrite, bornite, and, more rarely, chalcocite. In this syenite the vein and its many feeders carry bornite and considerable quantities of a bluish sulphuret of copper, in sheets $\frac{1}{2}$ to $\frac{3}{4}$ inch thick, which has a very crystalline structure and exhibits octahedral cleavage.*

Near the contact between the syenite and trap the latter rock is impregnated with magnetite, specular-iron, chalcopyrite and bornite. Excepting the syenite, wherever copper is found in the traps and amygdaloids on the Mendota property, it is in the metallic state. The occurrence of the sulphides and arsenides of copper in this isolated manner and in fissure-veins traversing

* Prof. Cooke, after a casual examination of this mineral, suggests that it is probably a pseudomorph of chalcocite after cuprite.

rocks more or less impregnated with metallic copper, seems to show a diversity of origin for the sulphur and arsenic on the one hand, and the copper on the other. It does not seem unreasonable to suppose the copper to have entered the vein-fissure from the adjoining rocks in solution, as carbonate, sulphate or silicate, and to have been then precipitated by sulphureted hydrogen and arseniureted hydrogen respectively. Or the copper may have been deposited in these as in the other veins, in the metallic state, and have been subsequently changed by the same gases. In the case of the pseudomorphous chalcocite, where the Mendota vein traverses syenite, cuprite must have been formed by the oxydation of chalcocite or of native copper, and the oxide must have been subsequently decomposed by sulphureted hydrogen.

The Huronian formation, which probably underlies all this region, contains in its upper members large amounts of carbonaceous matter in the form of graphite; the gases may have originated in a reduction of sulphates and arseniates by the carbon of these beds.

Among the pebbles in the Calumet conglomerate there is a variety of quartz porphyry, with a brown, compact, almost jaspery matrix, which only glazes slightly before the blowpipe. In this paste, there are numerous grains of dark quartz $\frac{1}{20}$—$\frac{1}{4}$ inch in diameter, and often more frequent crystals of flesh-red feldspar, apparently orthoclase,—$\frac{1}{10}$ to $\frac{7}{10}$ inches in length.

It not rarely happens, that in these flesh-red crystals there appear dirty green portions exhibiting the twine striation of a triclinic variety. The feldspar is hard and brilliant, but is nevertheless no longer intact; under the glass the crystals appear cavernous, 10 per cent or more of the substance being gone. This is the character of this porphyry in the freshest pebbles.

I have before me a pebble 4 inches in diameter, broken through the middle. It was the same variety of porphyry I have just described—the same brown matrix, with the same grains of quartz, and the same large crystals of orthoclase, often enclosing crystals of triclinic feldspar. But this pebble carries on its face the history of an extreme change. In the interior, where it is freshest, the matrix, still of the same brown color, has become so soft as to be easily scratched with the point of a needle. The quartz grains are highly fissured, and the surfaces of the fissures are covered with a soft light-green magnesian mineral. The feldspar, although it still resists the point of the steel needle, has generally lost its glance, and has an almost earthy fracture; it is lighter colored, and tends to spotted dirty-red and white. In places, specks of chlorite are

visible in the holes in the altered feldspar, and the cleavage planes often glisten with flakes of copper. As we go further from the middle of the specimen toward the original surface of the pebble, the matrix becomes much softer, though still with brown color and brown streak, and then changes to a soft green chloritic mineral, which whitens before the blow-pipe, and fuses on the edges to a grey glass. A little further from the center there is no longer a trace of the porphyry matrix: it is altered wholly to chlorite. The feldspar crystals are somewhat more altered here than they are in the middle of the pebble, but the quartz grains seem to have been in part replaced by chlorite. The change to chlorite is accompanied throughout by the presence of a large amount of copper. While in the interior of the pebble, the flakes of copper are confined to the cleavage planes of the feldspar, and the porphyry matrix exhibits scarcely a trace of the metal, the chlorite which has replaced the matrix contains in different parts of the specimen from 10 to 60 per cent, by weight, of copper.

In another pebble of the same porphyry, not only is the original matrix gone, but the usurping chlorite has been almost, if not wholly, replaced by copper; and we have as the remarkable result a quartz-porphyry, whose crystals of feldspar and grains of quartz lie in a matrix of metallic copper. There is still a very small amount of chlorite present, but it seems to have come from the change of the feldspar crystals and quartz grains.

In other pebbles of the same quartz-porphyry, containing, perhaps, less quartz, the alteration seems to have taken a somewhat different direction, or at least, the result before us is different. In the interior of the pebble, the matrix is of a darker and dirtier brown than in the previous cases, which may be due to the presence of manganese in the alteration product. Going from the middle, the brown color changes rather abruptly to a dirty greenish-gray; the material also becomes softer, but it is earthy, with an earthy odor, and gritty to the touch. The change seems here to be in the direction of kaolinization.

The entire pebble is permeated with minute shining threads and plates of carbonate of lime. The lighter-colored portion contains considerable copper, while nearer the surface of the pebble it is largely replaced by that metal. Pebbles showing the various alterations described above are by no means rare. Many of them, from 1 inch to 1 foot in diameter, are found every day.

III. *Conclusions.*

We may be permitted to draw a few conclusions from the facts brought out in the observations thrown together in the foregoing pages.

I. The *Chlorite* of the melaphyr, and consequently the distinctive character of that rock, is due to the alteration of hornblende or pyroxene. This seems to have been the first step toward the production of melaphyr proper. *Laumontite*, which we find alike in the beds containing the least and in those containing the most chlorite, and occurring both diffused and concentrated in seams, appears to have been formed either contemporaneously with the chlorite, or as the next step in the process.

The next step appears to have been the individualization, in amygdaloidal cavities, of *non-alkaline silicates*, viz: *laumontite*, *prehnite*, *epidote* respectively, according as the conditions favored the formation of one or the other of these.

Following these came the individualization of *quartz* in these cavities.

Perhaps we may be warranted in considering these minerals, together with the lime of the calcite that more rarely occurs in this portion of the series, as chiefly due to the decomposition of the pyroxenic ingredient of the rock.

So far as we may infer from the tabulated results, the concentration of *copper* in the amygdaloidal cavities does not appear to have begun till after the formation of the quartz.

In this part of the series falls also the formation of a chloritic or green-earth mineral, which in some manner has displaced prehnite, quartz, calcite, and with which copper, when present, appears to stand in intimate relation. Subsequently to this came the individualization of the alkaline silicates, viz: analcite, apophyllite, orthoclase. Here also seems to belong the formation of datolite.

The alkaline silicates represent the period of decomposition of the labradorite ingredient of the original rock, and when they occur in the mass of the rock (as distinguished from veins), it is only where the alteration of the rock has proceeded so far, that the amygdaloidal form has merged into the brecciated through the enlargement and union of the cavities.

The fact that calcite occurs at almost every step in the paragenetic series, and forms one of the most common of the secondary minerals, is proof that carbonic acid was very generally present throughout the whole period of metamorphism; it was probably the chief mediating agent in the processes, without being sufficiently abundant to prevent the formation of silicates.

II. The change of pyroxene to chlorite, as illustrated on an immense scale in the formation of the melaphyr, and the displacement of feldspar and quartz—quartz-porphyry—by chlorite as exhibited in pebbles of the conglomerate, point to an extremely important line of investigation for the chemical geologist. The alteration of the pebbles appears to have fol-

lowed two different directions according to the ruling conditions, viz: either toward chlorite or toward kaolinization; and as the result of the latter process is impregnated with calcite while the result of the former is free from carbonates, it would seem that the direction was determined by the presence or relative freedom from free carbonic acid. The deposition of calcite, if formed from the acid carbonate, would set free sufficient carbonic acid to prevent the formation of silicates of iron and magnesia.

III. *Copper*, wherever we can detect it with the eye, has already gone through a partial concentration. The presence of this metal in minute quantity in the sandstones of Lake Superior, is made evident by the stains of carbonate which form on the cliffs of the "Pictured Rocks." It is found here and there in the less amygdaloidal melaphyr in minute specks and impregnations, or even in a more concentrated form as thin sheets occupying the joint-cracks.

These occurrences increase in frequency in proportion as the rock is more amygdaloidal; in other words, the copper is more concentrated in those portions of the beds where the chemical change has been greatest. Where the rock has not passed beyond the strictly amygdaloidal stage, the copper occurs in the amygdules traversing these in flakes, or coating them in a film of greater or less thickness, to such an extent as to form from $\frac{1}{4}$ per cent to 3 per cent by weight of the rock over considerable areas. Finally, in those beds where the metamorphism has proceeded to such an extent as to wholly replace large portions of the amygdaloid by secondary minerals, epidote, calcite, quartz, chlorite, laumontite, etc., there the copper occurs in masses of many pounds, and sometimes of several tons weight, and in forms equalled in their irregularity only by those of the masses of secondary minerals accompanying the metal.

In each and all of these positions we find that the deposition of the copper took place subsequently to the decomposition and removal of a portion of the rocks, and subsequently to the deposition of laumontite, epidote, prehnite, and quartz, where these accompany it.

In all this we have direct evidence of the movement of some salt of copper in wet solution, and the concentration of the metal by accumulating deposition in places where the precipitating agent existed.

The Quebec group, to which these rocks belong, and which consist in various places of undoubted sedimentary strata exhibiting every degree of metamorphism, is as strongly characterized by copper as the Galena limestone is by lead.

Except in the melaphyrs of Lake Superior, the copper, so widely diffused in the strata of the Quebec group, exists either

in the various suphurets, or as oxidation products of these. Indeed we cannot well suppose the copper to have been deposited in submarine formations in any other condition than as sulphuret. Nor can we suppose it to have taken any other form permanently, so long as unoxidized organic matter remained in the beds. An oxidation of the sulphuret would be followed by reduction of the resulting sulphate to new sulphurets around the organic remains. In this way we may suppose the simplest and most common form of concentrated deposits —the impregnations—to have originated, as well as the farther enrichment of particular beds or zones—*fahlbands*—which may represent strata which were originally richer in organic substances, or which may have retained these longer than the other beds.

The trappean series of Keweenaw Point differ from the general character of the rocks of the Quebec group, both in lithological constitution and in having the copper in the metallic state. It is still an open question whether the trap which formed the parent rock of the melaphyr was an eruptive or a purely metamorphic rock. If it was eruptive, it was spread over the bottom of the sea in beds of great regularity, and with intervals which were occupied by the deposition of the beds of conglomerate and sandstones.

But the general diffusion of copper through the varied rocks of the Quebec group, speaks for a marine origin for the metal in these traps. It should seem probable that the copper in the melaphyrs was derived by concentration from the whole thickness of the sedimentary members of the group, including the thousands of feet of sandstones, conglomerates and shales which overlie the melaphyrs and including melaphyrs also—and especially, if these are purely metamorphic.

Among the most interesting questions connected with the occurrence of the copper, are those touching its condition previous to concentration during the amygdaloidal stage of metamorphism, the chemical combination by which this concentration was effected, and the character of the precipitating agent.

The great persistency of metallic sulphurets through the usual processes of metamorphism, and the almost universal association of sulphur with copper in crystalline rocks, renders it perhaps probable that this was here also the combination in which the metal was diffused, or rather, very partially concentrated. Traces of sulphur detected by Mr. Hochstetter in the melaphyr contiguous to the Hecla conglomerate point also in this direction, considering that the only acids generally present in the melaphyrs are silicic and carbonic acids, and if we add sulphuric acid as an oxidation product of the sulphurets, our choice of the form of solution, by which the final concentration

was effected, should seem to be limited to silicates, carbonates, and sulphates of copper. Probably all of these combinations took part in the process, but while we may consider the translocation of the copper to have been initiated by the sulphate, this salt must have been so soon decomposed by the abundant acid carbonate of lime* as well as by the alkaline silicates, that we cannot readily suppose the sulphate† to have generally effected the final concentration of large deposits. It is more probable that this was accomplished by the more permanent solutions of carbonate and silicate of copper respectively, as the circumstances favored. The position of the metallic copper in the paragenetic series shows it to have been deposited after the non-alkaline silicates, and before the formation of the alkaline silicates, i. e., after those minerals which resulted from the decomposition of the pyroxenic constituent of the rock, and before those which were formed by the destruction of the feldspar. Now this is what we should expect if we suppose the pyroxenic rock to have been altered to its present condition under the coöperation of water carrying carbonic acid and some free oxygen, because the oxygen must have been employed in oxidizing the carbonate of iron resulting from the decomposition of the pyroxene;‡ the oxidation of the sulphuret of copper could not, therefore, take place until the pyroxene had so far disappeared as to leave a relative excess of oxygen as compared with the amount of ferrous salts exposed to a higher oxidation. Throughout its deposits the copper exhibits a decidedly intimate connection with delessite, epidote and green-earth silicates, containing a considerable percentage of peroxide of iron as a more or less essential constituent; while among the other silicates, viz: analcite, laumontite, datolite, prehnite, only the last named, which alone seems subject to a considerable replacement of its alumina by ferric oxide, is especially favored by copper. This association is so invariable and so intimate that one is forced to the conclusion that there exists a close genetic relation between the metallic state of the copper and the ferric condition of the iron oxide in the associated silicates; that the higher oxidation of the iron was effected through the reduction of the oxide of copper and at the expense of the oxygen of the latter.

As regards the green-earth and that variety of chlorite or delessite which is intimately associated with the copper, they either immediately follow the copper in point of age or are contempo-

* A coating of gypsum covering very thin sheets of copper from the jointing-cracks of the melaphyr contiguous to the Hecla conglomerate, may be due to this decomposition, followed by the reduction of the copper.

† Compare Bischof Chem. u. Phys. Geol., I, p. 52, and III, p. 716.

‡ The result of this oxidation is seen in the brick-red color of the amygdaloids and in the brown color and spots of many of the melaphyr beds.

raneous with it, and they may be looked upon as having been formed under the influence of this reduction. Where copper is associated with prehnite it is invariably younger than the latter, a fact which would seem at the first glance to oppose the supposition that there is any relation between the peroxide of iron in the zeolite and the deposition of the copper. But we have seen that prehnite undergoes a change to delessite; we find these pseudomorphs in every stage of the process from the first green discoloration on the cleavage planes to the amygdule of delessite with prehnite structure. Now may we not consider the presence of iron in prehnite generally to be due to a beginning change, and the deposition of native copper in the Lake Superior prehnites to be partially or wholly correlated with the higher oxidation of the iron? In at least very many instances, if not in all, the deposition of the copper has been a result of a process of displacement of preëxisting minerals. In some rare instances the metal retains the form of its more or less remote predecessor, as in the pseudomorphs after some mineral (clay?) after laumontite.

Nowhere is this displacement more apparent than in the cupriferous conglomerates. In these the cement is the home of the metal, and in some places, as in portions of the Hecla and Calumet mines, it is wholly replaced by it; copper forming 20 to 50 per cent, by weight, of the rock. In these instances either chlorite or epidote is associated with the copper as minerals formed since the deposition of the conglomerate, while calcite very frequently replaces the cement in barren portions of the bed.

The cement of the conglomerates is of the same materials as the pebbles in a more comminuted form. The displacement of the whole mass of quartz porphyry in large pebble by chlorite and copper described above, is probably an illustration of the manner in which the cement was displaced on a more extended scale.

The absence of the ores of the baser metals—lead, zinc, nickel, etc., from the deposits of the trappean series, while they are present in the less metamorphosed rocks of the Quebec group in other localities, may be due to the greater intensity of the chemical action to which the melaphyrs have been subjected; an intensity which may be measured by the extent to which the process of concentration has been carried. Concentration is a process of removal relatively speaking, and concentrated deposits are accumulated masses of material arrested in the drainage channels of rock masses by the action of competent forces; if the arresting cause is absent from a given region, the removal will continue to another where it is present. If causes exist which are able to arrest one class of the substances in the passing solution, and are powerless as regards another class, then a separation will occur between the two classes.

Now, copper and silver belong to a class distinct from the baser metals in that, by reason of their smaller affinity for oxygen, they are more readily reduced to the metallic state, the condition of greatest permanence in presence of the usual reagents to which they are exposed. If the arresting cause of these metals was, as we have supposed, their reduction by protoxide of iron, it is a cause which would have been powerless as regards the salts of the baser metals, and we may suppose these to have continued in solution till they reached some region where they were arrested by the presence of organic matter, or of sulphureted hydrogen, etc.

ART. XLVII.—*Observations on the color of Fluorescent solutions*—No. II; by HENRY MORTON, Ph.D., President of the Stevens Institute of Technology.

SINCE the publication of my article on the above subject, in the August number of this Journal, I have discovered a curious action which, while it in no respect affects my general conclusions, nor the main observations on which they were founded, throws out one of the corroborative experiments by which I thought that they might be established when a spectroscope was not at hand.

Obtaining some very anomalous results of late, I was led to mistrust the action of the Geissler tubes in which the solutions had been examined.

They were of the ordinary kind of jacketed spirals, selected as being nearly identical in size and other particulars.

It had been observed from the first that the internal spiral gave a faint blue fluorescence which could only be seen on close inspection; and in all cases, the tube being but partly filled, it was considered that a light appearing in the part covered by the fluid, many times more bright than that from the uncovered part of the spiral, was sufficient evidence of fluorescence in the liquid.

Late experiments have, however, proved that this was not so. Any liquid, however devoid of fluorescent properties, gives all the appearance of fluorescing in these tubes, and on a little thought the cause of this became clear.

The only fluorescent light that can be seen from the glass of the spiral is that which comes off tangentially from the outer surface, that emitted radially being marked by the bright electric discharge behind.

In passing from the glass to air, most of the light will suffer total reflection at the outer surface of the glass, but if water or

any other liquid is substituted for the air, its greater refracting power (approaching that of glass) will diminish the above named action, so that much more of the light will reach the eye. The truth of this explanation was supported by the observation that the nearer the index of refraction in the liquid came to that of glass, the brighter was the light seen through it, while a liquid of higher refraction, like carbon bisulphide, seemed a little to weaken the effect by diffusion.

This fact renders of no account the observations before made on filtered and diluted solutions of turmeric, but a fresh observation with the spectroscope on tubes free from fluorescence has fully confirmed my former conclusions as to the true color of fluorescence in this liquid.

No correction need be applied to the description already published in the case of the asphalt solution, but I may add to what was there stated another striking example.

If one of the little Geissler tubes containing nitrogen, called "spectrum tubes," be jacketed by means of a perforated cork and a large glass tube, and the jacket filled with pure or non-fluorescent benzine, then illuminating the tube, and with a pipette dropping in that petroleum product called "cosmoline" (a lubricating oil made by E. H. Houghton, of Philadelphia), each drop will appear of a rich blue as it dissolves in the benzine, which soon acquires a magnificent blue fluorescence. Increasing, however, the quantity of cosmoline oil until its color begins to take effect, the tint of the fluorescence gradually changes to a rich green.

By a little care a blue solution may be superposed on a green one in the same tube.

Another semi-solid preparation of cosmoline, which has a very light color, gives a solution with benzine fluorescing of a magnificent blue.

I have this substance now under investigation, and hope soon to be able to make some further observations upon it.*

Returning to the solutions of turmeric, I have found that the fluorescent body in that substance is not its essential oil nor its brown coloring matter, but either the yellow coloring matter itself, or something so closely allied to it in solubility that I have thus far been unable to effect any separation.

In connection with this, let me say that I am much indebted to Mr. Robt. F. Fairthorne, of Philadelphia, who has aided me greatly in the preparation of the various constituents of turmeric in a state of purity.

In my former paper I mentioned that uranium nitrate in solution gave a very faint fluorescence.

*Mr. Houghton tells me that "cosmoline" is prepared from crude petroleum by evaporation in vacuo and filtration through animal charcoal only, without any chemical treatment.

This appearance I now find was due entirely to the above explained action of the tube, and a number of carefully conducted observations now convince me that this substance, while it fluoresces so vividly in the solid state, loses that property entirely when in solution.

I have also found that a saturated solution of acid quinine sulphate has its fluorescence much *increased* by dilution.

Lastly, let me remark that I by no means assert that *all* solutions fluoresce blue, but simply those which I have examined. There are many which I have as yet been unable to procure or study, whose relations in this respect I hope soon to investigate.

ART. XLVIII.—*Brief Contributions to Zoölogy from the Museum of Yale College. No. XVI.—On the Distribution of Marine Animals on the southern coast of New England;* by A. E. VERRILL.

IN connection with the investigations concerning the fisheries under the direction of Professor S. F. Baird, U. S. Commissioner, thorough explorations of the adjacent waters were undertaken in order to ascertain the character of the bottom, and the distribution of the lower animals, especially of those that furnish food for certain fishes. The Fish Commission had its headquarters at Wood's Hole, Mass., situated on the point of land between Vineyard Sound and Buzzard's Bay. In addition to the shore collections, extensive and systematic dredging operations were undertaken by means of a steam-launch in the waters of Vineyard Sound and Buzzard's Bay, and by the aid of a U. S. Revenue Cutter, the steamer "Moccasin," the dredgings were carried outward to the deeper parts of Muskeget Channel, situated off Martha's Vineyard, and from thence to a point off the mouth of Buzzard's Bay.* These explorations were made by means of dredges of several different sizes, of the usual forms; a rake-dredge of novel construction, especially adapted to soft muddy bottoms; an iron frame to which unraveled ropes, or "tangles," were attached for use on rocky bottoms; a large trawl-net; surface towing-nets for swimming creatures, etc.† The points where dredgings were made were carefully located on Coast Survey charts, and were sufficiently numerous to give a satisfactory knowledge of the nature of the bottom and its inhabitants throughout the region explored. The total number of hauls of the dredges, during the three

* The dredgings in the first part of the season were made under the direction of Mr. S. I. Smith, and later by Professor J. E. Todd, Professor A. Hyatt, Dr. A. S. Packard, and the writer, all more or less aided at various times by other naturalists, and especially by Dr. W. G. Farlow, who collected the algæ.

† Some of these instruments will be described in a future number of this Journal.

months, was about four hundred. The surface dredging also yielded many things of great interest.

At this time I wish to call the attention of zoölogists to one of the most important of the results of these investigations, leaving a full account of the large and valuable collections for another occasion. The discovery referred to is that while the shores and shallow waters of the bays and sounds, as far as Cape Cod, are occupied chiefly by southern forms, or the Virginian fauna, the deeper channels and the central parts of Long Island Sound, as far as Stonington, Conn., are inhabited almost exclusively by northern forms, or an extension of the Acadian fauna.

There is also a corresponding difference in the temperature of the water, the change in some cases amounting to 5° F., both at the surface and bottom, within a distance of two miles and without much change in the depth. And consequently there must be an offshoot of the arctic current setting into the middle of the Sound, although the shores feel the influence of the Gulf Stream, as shown by the occurrence of southern forms of pelagic animals in their waters.

The shores of Buzzard's Bay and Vineyard Sound present nearly all varieties of stations, and are, therefore, favorable for collecting. They are occupied, except on some of the outer islands, by an assemblage of animals characteristic of the coasts farther south, and known as the *Virginian fauna.* A few northern forms occur, however, on the rocky shores, which do not extend as far as New Haven. Among these *Purpura lapillus* is most conspicuous. This shell is associated there with *Eurosalpinx cinerey*, in about equal numbers, but at New Haven the latter occurs alone, while on the northern coasts of New England the *Purpura* is found unaccompanied by the other, which is rarely found north of Cape Cod. But in nearly all other respects the littoral fauna is very similar to that of the vicinity of New Haven, or the coasts farther south, as far as Cape Hatteras, making allowance only for differences in the stations, and especially for the absence of rocks south of New York.

In Vineyard Sound and Buzzard's Bay the water is everywhere shallow, usually from 3 to 8 fathoms deep, and rarely exceeding 12 or 14 fathoms, even in mid-channel. In Vineyard Sound the bottom is generally sandy, and extensive reefs of shifting sand are numerous, and often nearly destitute of life. But extensive regions of gravelly and shelly bottoms occur, and these are often almost completely covered by several species of compound ascidians, growing in large masses. One of these, which forms large hemispherical or irregular masses, made up of an aggregation of long slender colonies, united together at their bases and usually thickly covered

throughout with sand, is very abundant, often entirely filling the dredge with masses up to six inches in diameter. This is the *Amouroucium pellucidum* Verrill. Another one, nearly as abundant, forms smooth, cartilaginous masses in the form of flat lobes, crests, and plates, sometimes two feet long and about an inch thick, the surface covered with stellate colonies, while the color of the masses is of a delicate bluish or sea-green tint by reflected light, although yellow by transmitted light. This is *Amouroucium stellatum* V., described with the last in a former number of this Journal. A third species* of the same genus is also common, although still undescribed. This forms smooth gelatinous masses, varying from light orange to pale yellowish in color, with beautifully stellated colonies over its upper surface. With these were several simple ascidians, chiefly *Cynthia partita*† Stimp., and *Molgula Manhattensis* V., while creeping over them was a beautiful green species of *Perophora*,‡ which is the first representative of the social ascidians discovered on our coast. This species also occurred in abundance on the piles of the government wharf at Wood's Hole, associated with the three last named. In the interstices of *A. pellucidum* were numerous annelids of several species, and growing upon or with the ascidians were many species of hydroids, bryozoa, and sponges. Among the sponges a massive sulphur-yellow species (*Spongia sulphurea* Desor) is very conspicuous. While young this species perforates and destroys dead bivalve shells, but later in life grows up into hemispherical or irregular masses. Upon the same bottoms were found the common southern greenish star-fish (*Asterias arenicola*), *Amphipholis elegans*, *Gouldia mactracea*, *Eulima oleracea* on *Thyone briareus*, *Anachis avara*, *Columbella lunata*, *Cancer irroratus*, *Libinia canaliculata*, *L. dubia*, *Eupagurus pollicaris*, *E. longicarpus*, and many other less common species. On rocky and stony bottoms, and especially in the tide-way of the channel at Wood's

* *Amouroucium constellatum*, sp. nov. Masses thick, turbinate, often encrusting, surface usually convex, smooth, substance firm, gelatinous, translucent, but softer than in *A. stellatum*. Systems stellate, circular, oval or elliptical, often elongated, or irregular and complex. Zoöids much elongated, slender, the branchial tube short with six rounded lobes. Branchial sac elongated. Color of the masses usually light orange-red, varying to yellowish and pale flesh-color; the branchial orifices with six radiating white lines. Zoöids generally orange-yellow; the orifices and tubes with upper part of mantle bright orange, or lemon-yellow; branchial sac usually flesh-color or pale yellow, sometimes bright orange; stomach with bright orange-red glandular ribs; mantle with minute opaque white specks.

† *Cynthia stellifera* V. proves to be a depressed variety of this species.

‡ *Perophora viridis*, sp. nov. Individuals small, about ·10 to ·12 of an inch high, connected by slender stolons, and thickly covering the surfaces over which they creep. Test compressed, seen from the side scarcely higher than broad, oval, elliptical, or subcircular, often one-sided or distorted, with a short pedicle or subsessile at base. Branchial orifice large, terminal; anal lateral or subterminal, both a little prominent, with about 16 angular lobes, alternately larger and smaller. Test transparent; mantle beautifully reticulated with bright yellowish green; intestine yellow.

Hole, the southern purple sea-urchin (*Echinocidaris punctulata*), the orange star-fish (*Cribrella sanguinolenta*), the green star-fish, the coral (*Astrangia Danæ*), and many other interesting species occurred. All the species referred to, excepting the widely diffused species of *Cribrella* and *Amphipholis*, are either characteristic southern forms or else species that are not yet known except from the region explored. Several species were also obtained in Vineyard Sound which had not previously been found so far northward. Among these the flat sea-urchin with five perforations (*Mellita pentapora*) is especially worthy of mention, as it has hitherto been regarded as peculiar to the Carolinian fauna.* The free-swimming forms taken at the surface in this region were also numerous, and are likewise chiefly southern species, or if new they belong to southern types. Among the most interesting were *Salpa Cabotii*, which occurred in vast quantities about the first of September, and was found in abundance off Gay Head, as well as in the Sound; a splendid species of *Saphirina*, reflecting brilliant blue and red colors like a fire opal, which occurred mingled with the *Salpæ;* a new free-swimming crab; *Idotæa robusta* Kr.; innumerable young lobsters, crabs, and shrimp, in the zoea and megalops stages of growth; numerous jelly-fishes, among which *Mnemiopsis Leidyi* was perhaps the most abundant, but a species of *Cyanea* and *Dactylometra quinquecirra* were common, and both frequently gave shelter to several young "butter-fishes" (*Poronotus triacanthus*) of all sizes, from those just hatched up to two inches or more in length. In some cases twenty or more were found together under one jelly-fish. They also occurred, in the evening, under *Zygodactyla Grœnlandica* earlier in the season. The "Portuguese-man-of-war" (*Physalia arethusa*) was met with several times. Two Pteropods not before recorded from the United States coast were obtained,—one of them (*Stiliola* sp.) living, associated with *Salpa;* but of the other (*Cavolina tridentata*) the shells only were dredged, but in a very fresh condition.

In the deeper outer channels, as between Gay Head and Nomans-land, and at nearly all points outside of the latter, where the water is more than ten fathoms in depth, the fauna is very different from that of the sounds and bays, and closely resembles that of Massachusetts Bay and the coast of Maine. The difference in the temperature of the water is also well-marked. The surface temperature, during the latter part of August, was 69° to 71° in Vineyard Sound. On Sept. 9th, in the mouth of Vineyard Sound, west from Gay Head, the surface temperature was 67° F., and the bottom, in 15½ fathoms, was 63°; but pro-

* This and *Lytechinus variegatus* were found by the writer, Mr. S. I. Smith, and Prof. J. E. Todd at Great Egg Harbor, N. J., last spring, but they are very rare at that locality.

ceeding about two miles farther out, off No-mans-land, the surface temperature was 62°, and the bottom, in 18 fathoms, was 58½°, showing a decrease of 5° within this short distance, both at the surface and bottom. A few miles farther out, at the same depth, the bottom temperature was 57°, which was the lowest temperature obtained. A short distance west of No-mans-land, on a gravelly bottom in 11 fathoms, where cod-fish are caught in winter, the temperature was 63° at the surface and 59° at the bottom. Off the mouth of Narragansett Bay, about sixteen miles south from Newport, the depth over a limited area is 29 fathoms, which was the deepest water found. At this locality the surface temperature was 62° and the bottom 59°. The bottom, in these deeper waters, was generally composed of soft mud, filled with innumerable tubes of worms and Amphipod crustacea, among which a species of *Ampelisca*, which makes a soft flabby tube, two or three inches long and covered with mud, is extremely abundant. At the last named locality numerous specimens of the rare and beautiful *Epizoanthus Americanus* V. was found coating the shells inhabited by hermit-crabs (*Eupagurus Bernhardus*) and finally absorbing the shells entirely. This remarkable Actinian has been found previously only on two occasions,—first on a deep bank off the coast of New Jersey, by Capt. Gedney; and since in deep water off Massachusetts Bay. With this was also found a rare Holothurian (*Molpadia oölitica*), previously known only from specimens taken from fish stomachs.

The various muddy bottoms in the deeper and colder areas yielded nearly the same assemblages of animals, most of which are either strictly northern types, many of them not before observed so far south; or else species of wide range extending much farther north as well as south. Among those of special interest are the following: of RADIATA, *Edwardsia farinacea* V., previously known only from the Bay of Fundy, *Thyonidium* sp.; of MOLLUSCA, *Molgula pilularis* V. and *Glandula mollis* Stimp., both known before only from the Bay of Fundy, *Cyprina Islandica*, *Cardita borealis*, *C. Novangliæ*, *Yoldia sapotilla*, *Y. limatula*, *Nucula proxima*, *N. delphinodonta*, *Cardium pinnulatum*, *Astarte quadrans*, *A. castanea*, *A. lutea* (?) Perkins, *Lyonsia hyalina*, *Anatina papyracea*, *Lucina filosa*, *Callista convexa*, *Crenella glandula*, *Modiolaria nigra*, *M. corrugata*, *Pecten tenuicostatus* (young = *P. fuscus* Lins.), *Buccinum undulatum*, *Chrysodomus pygmæus* (large and abundant), *Crucibulum striatum*, *Margarita obscura*, *Cylichna alba;* of ANNELIDS, *Clymene torquata* Leidy, *Ophelia simplex* Leidy?, *Trophonia* sp., *Sternaspis fossor*, *Aphrodite aculeata* (large and common), *Nephthys* (large species), *Sipunculus Bernhardus*, and species of *Nereis*, *Lumbriconereis*, *Aricia*, etc.; of CRUSTACEA, species of *Ampelisca* (abundant),

Unciola irrorata, and several other Amphipods, *Crangon vulgaris*, *Pandalus annulicornis*. On sandy bottoms *Echinarachnius parma* was very abundant, as it was, also, everywhere in the sounds, for it is a widely diffused species, occurring as far south as Great Egg Harbor; *Molgula arenata* St. also occurred, with a few other species of interest. A large species of sandy *Foraminifera*, often a quarter of an inch in diameter, was abundant. In the channel between Gay Head and No-mans land the bottom is gravelly and stony, and here some very interesting species were found; among the RADIATA were *Alcyonium carneum* Ag., *Edwardsia* (new species), *Grammaria gracilis* St., and many other hydroids, *Cribrella sanguinolenta*, *Asterias vulgaris* V., *Ophiopholis aculeata* Gray, *Euryechinus Drobachiensis* V.; of ASCIDIANS, *Amouroucium pallidum* V., *Molgula papillosa* V., *Cynthia carnea* V., *C. hirsuta* Binney, *C. partita* St., all northern species except the last; of shells many of the northern forms already named and some additional species; of CRUSTACEA, *Eupagurus Bernhardus*, *Cancer borealis* (thrown on shore and fragments dredged), *C. irroratus*, with numerous *Amphipods*.

The brief lists of species given above are quite sufficient to show the marked northern character of the fauna in the deeper waters of this region. Several of the northern shells enumerated above have also been dredged by Mr. Sanderson Smith in Gardiner's Bay, L. I., and some of them have long been known from Montauk Point. Mr. Linsley, in his catalogue of the shells of Connecticut,* also records many of the same northern species with a few additional ones, from Stonington. I have been informed by Mr. H. C. Trumbull, who collected the shells attributed to Stonington, that all these northern species were obtained by him from the stomachs of haddock, &c., which were taken within a few miles of Stonington. This would indicate that the northern cold current has a decided influence as far westward as that locality, beyond which its influence has not yet been traced.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On nitrous and hyponitric acids.*—HASENBACH has repeated the experiments of Nylander on the nature of the red vapors formed in the oxidation of arsenous by nitric acid. By condensing these vapors, Nylander obtained a blue liquid boiling at 13° C., which appeared to have the formula $N\Theta_2$, and therefore to be isomeric with hyponitric acid. Hasenbach employed an apparatus constructed entirely of glass, and dried the liquid product ob-

* This Journal, I, vol. xlviii, 1845.

tained with calcined cupric sulphate. The deep blue liquid obtained began to boil at 2° C., giving off much nitric oxide; the thermometer then rose rapidly to 10° C.; between 10° and 13° but little nitric oxide was given off. Between 13° and 22° the temperature rose rapidly, and at 22° the remaining portion of liquid passed over with the brown-red color of hyponitric acid. As the author could obtain no liquid with a constant boiling point between 10° and 13°, this portion of liquid was analyzed and found to have nearly the composition of hyponitric acid, $N\Theta_2$. The vapor density of this liquid, 2·177, also corresponded with that of hyponitric acid, which is 2·061 as calculated from the formula. The vapor when passed through a heated tube became colorless, but the color appeared again in the colder portion of the tube. Further investigation proved that the compound boiling between 10° and 22° was a mixture of much hyponitric with a little nitrous acid. The general results of the author's investigation are as follows:

(1.) The assumption of Nylander that in the oxidation of arsenous by nitric acid, of density 1·33, an isomer of hyponitric acid is formed, is without foundation. In this case, according to the concentration of the nitric acid, either hyponitric acid, or a mixture of nitrous and hyponitric acid, is formed.

(2.) Hyponitric acid and nitric oxide unite at a high temperature to form nitrous acid, which may in this manner be prepared chemically pure.

(3.) Hyponitric acid and chlorine under the same circumstances unite to form chloronitric acid, $N\Theta_2Cl$.

(4.) Bromonitric acid, $N\Theta_2B_2$, could not be obtained pure by this process, as the product is decomposed by boiling.

(5.) Iodine and hyponitric acid do not combine at a high temperature.

(6.) Cyanogen and hyponitric acid give, with the aid of heat, a highly explosive compound, perhaps cyanonitric acid, $N\Theta_2Cy$.

(7.) Chlorine, bromine and cyanogen do not unite in the cold with hyponitric acid, or do so only to a very limited extent.

(8.) Nitrous acid and oxygen unite at ordinary temperatures to form hyponitric acid.

(9.) Sulphurous acid and carbonic oxide unite with hyponitric acid, even at a low temperature, to form compounds not further investigated.

All these facts speak in favor of the assumption that the molecule of fluid hyponitric acid is $\left\{\begin{matrix}N\Theta_2\\N\Theta_2\end{matrix}\right.$; that of the vapor above 100°, on the contrary, $N\Theta_2$.—*Journal für prakt. Chemie, Band* iv, p. 1. (New Series.) W. G.

2. *New method of separating magnesia from potash and soda.*—SCHEERER separates the alkaline metals from magnesia in the following manner: The solution of the chlorides of the bases which may contain ammoniacal salts is to be evaporated, in a platinum vessel, not quite to dryness; a larger quantity of powdered ammonic oxalate is then to be stirred in, the whole heated to perfect

dryness, and finally gently ignited, care being taken to expose every portion of the saline mass to the same high temperature. The mass is then to be heated with water—heated to the boiling point and filtered. The magnesia remains on the filter as carbonate, while the alkalies are present in the filtrate as carbonates perfectly free from magnesia. The separation here depends, partly upon the formation of magnesic oxalate, which is decomposed by ignition into carbonate, partly upon the fact that the temperature at which ammonic oxalate is decomposed is higher than that at which ammonic carbonate is volatalized. The ammonic oxalate must of course be so pure as to leave no residue on ignition. In the presence of sulphuric acid the method is not applicable, probably because the ammonic sulphate is decomposed after the oxalate. —*Journal für prakt. Chemie, B.* iii, p. 476. W. G.

3. *On the methylation of the phenyl group in anilin.*—Berthelot observed some years since that small quantities of ethylamin are formed by the action of alcohol upon ammonic chloride at a high temperature. The reaction, which in this case takes place with great difficulty, was employed by Bardes, chemical director of the anilin color factory of Poirrier and Chappat in Paris, for the production of methyl anilin, dimethyl anilin, ethyl anilin and diethyl anilin, methylic or ethylic alcohol and chlorhydrate of anilin being heated together. In this reaction, however, other products are formed at the same time with the salts above mentioned, and these have been examined by Hofmann and Martius, who operated upon very large quantities of material, repeating the process twice in succession upon the same material. The very beautiful and interesting results of this investigation are as follows: The methylation or ethylation takes place in two distinct phases, the first being the introduction of methyl or ethyl into the phenylammonia; the second, the replacement of the hydrogen of the phenyl itself by methyl or ethyl. So far as the final results are concerned, these reactions may be expressed by the equations:

$$\left.\begin{array}{l} \left.\begin{array}{l} C_6H_5 \\ H \\ H \end{array}\right\} N.HCl + \left.\begin{array}{l} CH_3 \\ H \end{array}\right\} \Theta = \left.\begin{array}{l} C_6H_5 \\ CH_3 \\ H \end{array}\right\} N.HCl + \left.\begin{array}{l} H \\ H \end{array}\right\} \Theta \\ \left.\begin{array}{l} C_6H_5 \\ CH_3 \\ H \end{array}\right\} N.HCl + \left.\begin{array}{l} CH_3 \\ H \end{array}\right\} \Theta = \left.\begin{array}{l} C_6H_5 \\ CH_3 \\ CH_3 \end{array}\right\} N.HCl + \left.\begin{array}{l} H \\ H \end{array}\right\} \Theta \end{array}\right\} \text{1st phase.}$$

$$\left.\begin{array}{l} \left.\begin{array}{l} C_6H_5 \\ CH_3 \\ CH_3 \end{array}\right\} N.HCl + \left.\begin{array}{l} CH_3 \\ H \end{array}\right\} \Theta = \left.\begin{array}{l} C_6H_4(CH_3) \\ CH_3 \\ CH_3 \end{array}\right\} N.HCl + \left.\begin{array}{l} H \\ H \end{array}\right\} \Theta \\ \left.\begin{array}{l} C_6H_4(CH_3) \\ CH_3 \\ CH_3 \end{array}\right\} N.HCl + \left.\begin{array}{l} CH_3 \\ H \end{array}\right\} \Theta = \left.\begin{array}{l} C_6H_3(CH_3)_2 \\ CH_3 \\ CH_3 \end{array}\right\} N.HCl + \left.\begin{array}{l} H \\ H \end{array}\right\} \Theta \end{array}\right\} \text{2d phase.}$$

It can, however, scarcely be doubted that methylic chloride and water are always formed first, and that methylic chloride is the true agent of substitution. In the basic oils submitted to examination, the authors discovered besides dimethyl anilin four other dime-

thylated monamines—namely, dimethylated toluidin, xylidin, cumidin and cymidin; in symbols the compounds:

Dimethyl—

Anilin, $\left.\begin{matrix}C_6H_4\\(CH_3)_2\end{matrix}\right\}N.$

Toluidin, $\left.\begin{matrix}C_7H_7\\(CH_3)_2\end{matrix}\right\}N=\left.\begin{matrix}C_6H_4(CH_3)\\(CH_3)_2\end{matrix}\right\}N.$

Xylidin, $\left.\begin{matrix}C_8H_9\\(CH_3)_2\end{matrix}\right\}N=\left.\begin{matrix}C_6H_3(CH_3)_2\\(CH_3)_2\end{matrix}\right\}N.$

Cumidin, $\left.\begin{matrix}C_9H_{11}\\(CH_3)_2\end{matrix}\right\}N=\left.\begin{matrix}C_6H_2(CH_3)_3\\(CH_3)_2\end{matrix}\right\}N.$

Cymidin, $\left.\begin{matrix}C_{10}H_{13}\\(CH_3)_2\end{matrix}\right\}N=\left.\begin{matrix}C_6H(CH_3)_4\\(CH_3)_2\end{matrix}\right\}N.$

The terminal member of this group is still wanting, and would have the formula:

$$\left.\begin{matrix}C_{11}H_{15}\\(CH_3)_2\end{matrix}\right\}N=\left.\begin{matrix}C_6(CH_3)_5\\(CH_3)_2\end{matrix}\right\}N.$$

The authors remark that the names selected do not necessarily imply that the compounds are identical with those already known, since they may be only isomeric with them. Thus the xylidin already known may not give by methylation with methylic iodide a dimethyl xylidin identical with the above, but only one isomeric with it. Thus we already know a solid and a fluid modification of toluidin. By treatment with methylic iodide, solid toluidin yielded a dimethyl base, which in many respects resembled that mentioned above, but which yet did not appear to be certainly identical with it, although the tertiary monamines derived from both bases appeared to exhibit no differences whatever. The authors promise a further investigation of the whole subject, and chemists will look with the greatest interest for their results.—*Berichte der Deutschen Chem. Gesellschaft, Jahrgang* iv, p. 742. W. G.

4. *On the derivatives of hydric phosphide which correspond to ethylamin and diethylamin.*—A. W. Hofmann has succeeded in obtaining phosphorus compounds corresponding to ethylamin and diethylamin. The process consists in digesting an alcoholic iodide with iodide of phosphonium and a metallic oxide. When, for instance, one part by weight of zinc-white, four of iodide of phosphonium, and four of iodide of ethyl, are digested together for six to eight hours, at a temperature not exceeding 150° C., a nearly white crystalline mass is obtained, which is chiefly the iodide of ethly phosphin, the reaction being expressed by the equation:

$$2C_2H_5I+2PH_4I+ZnO=2P(C_2H_5)H_3I+ZnI_2+OH_2.$$

In this case, however, a certain quantity of diethyl phosphin is always formed, the reaction being expressed by the equation:

$$2C_2H_5I+PH_4I+ZnO=P(C_2H_5)_2H_2I.ZnI_2+OH_2.$$

The tertiary and quaternary derivatives of phosphonium are not formed in this reaction. These, Hofmann had already shown, might be obtained by the action of the alcohols themselves on phosphonic iodide. The separation of the mono- and di- compounds

is very easy. Water readily decomposes the first, setting the phosphine free, and leaving the latter unchanged in solution. The phosphine may then be separated by distillation, and dried by means of potassic hydrate. From the residue in the retort, the dicompound may be separated by distilling with caustic soda in an atmosphere of hydrogen. Monethyl phosphin, $P(C_2H_5)H_2$, is a colorless, transparent, mobile liquid, lighter than water, boiling at 25° C., without action on vegetable colors, and possessing a truly fearful odor. In contact with chlorine, bromine, iodine, and fuming nitric acid, it takes fire. It unites with sulphur and carbonic disulphide to form fluid compounds. With chlorhydric, bromhydric and iodhydric acids it unites to form salts. The chlorhydrate forms a beautiful carmine-red, crystalline salt with platinic chloride. Diethyl phosphin, $P(C_2H_5)_2H$, is a colorless, transparent, perfectly neutral liquid, insoluble in and lighter than water. It boils at 85° C., and has a penetrating and persistent odor. It oxidizes readily in the air, and sometimes even takes fire; it also unites with sulphur and carbonic disulphide to form fluid compounds. Diethyl phosphin unites with acids to form salts which, with the exception of the iodhydrate, are difficult to crystallize. Methyl phosphine, $P(C_2H_5)H_2$, is a colorless gas, with an odor even worse than that of the ethyl compound. It may be condensed to a liquid by cold or pressure. The salts of this base are decomposed by water. Dimethyl phosphin is a colorless liquid, insoluble in water, and boiling at 25° C. like its isomer ethyl phosphin. It takes fire when exposed to air, and forms very soluble salts with acids.—*Berichte der Deutschen Chem. Gesellschaft, Band* iv, pp. 430 and 605. W. G.

II. Geology and Natural History.

1. *Note on an Apparent Violation of the Law of Regular Progressive debituminisation of the American Coal beds coming East;* by J. P. Lesley. (Proc. Am. Phil. Soc., xii, p. 125, 1871.)—In the course of a Geological survey of certain lands in Somerset county, Pennsylvania, it appeared that the beds of coal existing at Ursina held much less volatile matter than was expected. The gas coals of Westmoreland county, which come east as far as Connellsville, only thirty miles west of Ursina, hold between 30 and 40 per cent. of volatile matters. Three analyses show Ursina coals to have but 17 per cent., while a fourth gives 22 per cent. This puts the Somerset county coals into the *semi-bituminous* class. Yet the specimens were taken from gangways, a good many years old, and several hundred feet from the outcrop, under high hill cover, at a point on the *western* border of the First Bituminous Coal Basin of Pennsylvania, near the Maryland and Virginia State line. More properly we should say that the Ursina coals lie in the second synclinal of the First Basin. For the Negro Mountain anticlinal comes up from Virginia and splits the First Basin into two in Pennsylvania. The Mountain dies down at Castleman's River; but the anticlinal axis runs on

northward. The First Basin is similarly split into two, east of Johnstown, by the Viaduct anticlinal, which may or may not be an actual prolongation of Negro Mountain.

To make the situation understood, the following extracts from my report to the owners of the property will suffice. The accompanying map shows the Backbone of the Alleghany passing by Altoona. This is the eastern edge of the First Bituminous Coal Basin. The two long parallel mountains between Ursina and Connellsville enclose the Second Bituminous Coal Basin of Pennsylvania. The Third, Fourth and Fifth lie west of it, and the Sixth occupies the northwest corner of the map; no mountains separating the last four. [The map referred to is here omitted].

The property surveyed, in this instance, lies in my old tramping and camping ground of 1840, during the fifth year of the State Geological Survey. The report which Mr. James T. Hodge and myself made to Mr. H. D. Rogers, Chief of the Survey, may be found recorded in the Fifth Annual Report (1841), pages 89-92, which I will here recapitulate in the *descending* order of the beds, for convenience of comparison.

The Pittsburg bed, I, has been eroded from the whole country between the Alleghany Mountain and Chestnut Ridge (at Connellsville and Blairsville) except two hill tops; one near Salisbury, and the other near Ligonier. It is possible also that a third exception may be discovered in the high hill country south of Johnstown, where a conspicuous bench runs along the hill-tops for several miles.

Limestone 20 feet below I, 6 feet thick in the Ligonier Basin.

Coal bed H, 50 feet below I, 3 feet thick in the Ligonier Basin; 1 foot thick in the Salisbury Basin.

Coal bed G, 100 feet below H, 1½ feet thick in the Salisbury Basin; encircles the highest hill-tops in the Ursina Basin with a conspicuous bench. Fort Hill is not quite high enough to have it.

Red Shales between G and F.

Coal bed F, 90 feet below G; generally small; but 4 feet thick in the Salisbury Basin. It forms the high terrace of the Fort Hill. Mahoning Sandrock.

Coal bed E, "Upper Freeport," 50 feet below F; 2 feet thick, on 2 feet of *Limestone* (over it Shales with *ore-balls*) in Ursina Basin; 3 feet thick, on 5 feet of *Limestone* in the Salisbury Basin.

Coal bed D, "Lower Freeport," 60 feet below E, 6 feet thick in Ursina Basin; 4 feet, farther north; over 10 feet of sandstone with *ore-balls*, in two beds, 7 feet asunder, 11 inches in all. This ore-ball horizon is very extensive north and south of the River.

Coal bed C, 20 feet below D, 2½ to 4 feet thick.

Coal bed B, 30 feet below C on Cox's Creek, 40 on Laurel Hill Creek (N. Fork), and 60 at Confluence; 4 feet thick over 8 feet of *Limestone* on the river; 1½ feet thick over 4 feet of *Limestone* on the North Fork. Twenty feet above B lie 15 feet of Shales, etc., containing *ore-balls*, on Spring Run, below Pinkerton's Bend of the river.

Coal Bed, 22 feet below Limestone, on west bank of Castleman's river, ¼ mile above Zook's Run ford, and on North Fork at old salt boring; carries 5 feet of Shale, containing 1 foot of *ore-balls.*

Coal bed A, 70 feet below B; 22 inches thick, at Shroff's Bridge over Castleman's river.

Conglomerate; 30 feet below A; the interval being massive sandstone.

Such was the general scheme of the Coal measures made out during the old survey, and, however subsequently modified, it has been of incalculable value in all subsequent special and private investigations. It was a very successful attempt to reduce to system the heterogeneous mass of details collected from all parts of the Bituminous Coal Region of western Pennsylvania outside, or to the east, of the Monongahela River Upper Coal Beds, and of the Alleghany River Lower Coal Beds. It was by the collation of these three generalizations, that the first knowledge of the true order of the American Coal Measures was obtained, a starting point and a basis for all the Western Surveys.

[The details with regard to the region and the beds of rock and coal are here omitted]. Analyses of specimens from one of the beds called the Ferriferous Bed afforded as a mean of two analyses:

Volatile matters and water	17·125
Water alone	
Fixed carbon	68·535
Ashes	14·34

A specimen from another opening, near the mouth of Brown's Creek, gave:

Water	0·55
Volatile substances (gas)	21·90
Carbon (coke)	60·98
Sulphur (in ash)	0·62
Ash	15·95

That both the 6-foot and the 3-foot Ursina beds, situated at the western limit of the 1st Bituminous Coal Basin, should have only 17 per cent. of volatile matters,—not more than the coals of the Broad Top Region lying one hundred miles to the east of Ursina —is truly remarkable. The Broad Top beds are tilted and faulted abundantly. The Somerset County beds are almost perfectly undisturbed. The coal in one gangway showed 22 per cent. of volatile substances. But even this is no greater than the coals of the Alleghany Mountains and the coals of the Cumberland Coal Region.

No proper scheme of the *rates* of *debituminization to easting* and to *disturbance*, can be obtained until all the analyses of each bed in the series of Coal Measures shall be tabulated apart from the rest. We may then expect to learn something also respecting the influence of specific vegetation upon the percentages of coke and gas.

But in the outset one source of error must be guarded against. The specimens of coal, from which the foregoing analyses were made, were obtained in the walls of old gangways. It is possible that they had been long enough exposed to the air to lose some of their hydro-carbons by spontaneous evaporation. The rate at which this goes on in coal mines and exposed heaps is variously stated by those who have investigated the subject.

Dr. Richters made a recent communication to a German Journal, in which he states his opinion that the weathering of coal depends upon its ability to absorb oxygen, converting the hydro-carbons into water and carbonic acid. At a heat, say of 375° F., only 5 or 6 per cent. of the carbon accepts oxygen; the rest seems to show little or no disposition to affine with it. The process is apparently dependent upon the per-centage of hydrogen. But with coal, cold or at ordinary temperature, the oxidation is so slow as to be imperceptible, even after exposure for an entire year. He says moisture has no accelerating effect, unless pyrites is present in quantity. Pure coal, heaped up for nine months or a year, unprotected by the weather and not allowed to become heated, is changed no more than it would be in a perfectly dry place.

Herr Grundmann, of Tarnowitz, on the other hand, has recently published elaborate experiments proving the effects of exposure on bituminous coals to be most serious. Coal which he exposed for nine months lost *fifty per cent.* of its value as fuel. His conclusions excited such doubts, that his experiments were repeated, in connection with Herr Varrentrapp, of Brunswick, who proved by laboratory experiments that oxidation took place at common temperatures. Three months sufficed to rob coal, kept uniformly at 140° C. (284° F.) of *all its carbon*, a heat less than that evolved in coal heaps exposed to the air.

Grundmann proved that the decomposition was the same in the middle of the heap as at the surface, and reached its maximum about the third or fourth week: that half of the oxygen was absorbed during the first fourteen days; that a coal poor in oxygen absorbs it most rapidly; that moisture is an important condition; that coals making, when freshly mined, a firm, coherent coke of good quality, make, after even only *eleven days* exposure, either no coherent coke at all, or coherent coke of quite inferior quality. For gas purposes, also, the coal is greatly injured.

It is evident that these facts have an important bearing on the value of the analyses given above.

2. *On the Oil wells of Terre Haute, Indiana;* by T. Sterry Hunt. Abstract of a paper presented to the American Association for the Advancement of Science, Indianapolis, Aug., 1871.—In previous publications I have endeavored to show that the source of the petroleum in southwest Ontario, and probably in some other localities, is to be sought in the oleiferous limestones of the Corniferous and Niagara formations, both of which abound in indigenous petroleum. I have, however, expressed the opinion that the overlying sandstones in Pennsylvania are also truly oleiferous.

In a paper read to this Association last year, I showed that the Niagara limestone at Chicago holds imprisoned in its pores an enormous quantity of oil, and remarked that the reservoirs which supply the wells in other districts are fissures along anticlinals, which, though sometimes occurring in strata above the oil bearing horizon in Ontario, frequently occur in the Corniferous limestone itself. Hence the view held by some that the source of the oil in that region is to be sought in the overlying strata is negatived.

In Ontario there intervenes between the Corniferous and Niagara formations, the great saliferous series known as Onondaga or Salina formation. This, however, is wanting to the westward, where the first two formations come together, and according to Professor Cox, where exposed at North Vernon, Indiana, are both oleiferous.

A well lately sunk at Terre Haute, Indiana, in search of fresh water, has shown the existence of a productive source of oil in that region. It was carried 1,900 feet, and yields about two barrels of oil daily. A second well, a quarter of a mile east of north from the first, has given a supply of twenty-five barrels of oil daily. After passing through 150 feet of superficial sand and gravel, the boring was carried to a depth of 1,625 feet, where the oil was struck.

According to Prof. Cox, the strata passed through are as follows: Coal measures 700 feet; Carboniferous limestone, with underlying sandstone and shales, 700 feet; black pyroschists, regarded as equivalent of the Genesee slates, 50 feet. Beneath this, at a depth of twenty-five feet, in the underlying Corniferous limestone, the oil vein was met with.

The oil in the first well was found at the same horizon. A third well, about a mile to the eastward, was carried to a depth of 2,000 feet, but no traces of oil were met with.

This locality, on the Wabash river, is, according to Prof. Cox, on the line of a gentle anticlinal or uplift which is traced a long distance to the west of south. The relation of productive oil wells to such anticlinals was pointed out by Prof. Andrews and by myself in 1861.

Postscriptum.—In a note in this Journal for September (page 215), Mr. A. D. Warner refers to a paper by me on *The Oil-bearing Limestone of Chicago*, which appeared in this Journal for June (p. 420), and quotes from me as saying therein that "much of the petroleum of Pennsylvania, Ohio, and the adjacent regions, is indigenous to certain sandstones in the Devonian and Carboniferous rocks." It would have given a more correct idea of my views, had he cited the words preceding; after maintaining that a principal source of the petroleum is in lower rocks, in fact the limestone of the Niagara and Corniferous formations, I added: "There is however, reason to believe, as I have elsewhere pointed out, that much of the petroleum, etc." I there referred to the Geology of Canada, 1863-66, page 24, where I cite from two papers of J. P. Lesley (Amer. Phil. Society, x, 33, 187), and it is from the evidence there given by him, and not upon my own observations,

that I conclude "we have reason to believe" in the existence of indigenous petroleum in the sandstones in question. Lesley there states that the oil in these rocks occurs in thin fissures corresponding to the remains of plant stems which have disappeared, having been converted into petroleum, an observation which is an answer to Mr. Warner's remark that while the sand-rocks in question are seen in certain parts to abound in fossil plants, "they contain nothing from which the petroleum could possibly have been derived". While I have constantly maintained the view held by Mr. Warner, that the oil, so far as I have studied it, comes from a lower horizon, I am nevertheless not disposed to reject the statements of so skilled an observer as Mr. Lesley. Mr. Warner will find in the facts ascertained at Terre Haute a confirmation of the view that the petroleum in this region, at least, comes not from the sandstone, nor even from the underlying pyroschists, but from the still lower limestones of the Niagara and Corniferous formations.

Montreal, Sept. 8, 1871.

3. *Surface Geology of New Brunswick;* by G. F. MATTHEW, Esq., (Proc. Nat. Hist. Soc. of New Brunswick, April, 1871.)—The author closes his paper with the following conclusions.

1st. The present summer climate of a large part of Acadia is such as to compare with that of the region around Lake Superior, where according to Prof. L. Agassiz and Sir W. E. Logan, glaciers existed during the Drift period. The resemblance in the climatic conditions of the two regions is shown both by their mean summer temperatures and by the distribution of indigenous plants. (See Can. Nat., June, 1869.) The authority of Messrs. L. Agassiz and J. D. Dana may be quoted in favor of the former existence of glaciers in southern New England, which enjoys a summer temperature considerably higher than Acadia.

2nd. Some of the phenomena of the drift epoch, such as the direction and position of the glacial striæ and the distribution of the clays, do not appear susceptible of explanation on the hypothesis that icebergs and ocean-currents alone produced them. And it seems reasonable to suppose that a great sheet of ice similar to the continental glaciers of Greenland and the Antarctic regions, which will explain these phenomena, covered the Lower Provinces during the glacial epoch; and that while the general course of this mass was southward toward the then existing ocean, the motion of the deeply-buried ice in the bottom of the glacier was partly governed by the configuration of the land beneath it.

3rd. That while the western portion of this icy mass was steadily moving down the Atlantic slope from the table land of northern Maine, and the eastern pushing across the low swell of land which separates the Gulf of St. Lawrence from the Bay of Fundy, the motion of the central portion of the ice-sheet, which could have had but a slight inclination, would have been impeded or nearly arrested by the southern hills of New Brunswick.

4th. That such portions of the glacier as were pushed over the tops of these hills, or through the narrow valleys between them, conformed in some degree to the slope of the surfaces over which they moved.

5th. The erosion effected by the glacier was chiefly in the softer rocks of the country; the harder ones resisting the attritive power of the ice, and preserving with comparatively little change their pre-glacial outline.

4. *Remarks on Fossil Vertebrates from Wyoming.* (Proc. Acad. Nat. Sci. Philad., August 8, 1871.)—Prof. LEIDY remarked that the collections of fossils presented this evening by Drs. J. Van A. Carter and Joseph K. Corsos were of unusual interest. They consist of remains mainly of turtles, with those of mammals and crocodiles, and were obtained from the tertiary deposits in the vicinity of Fort Bridger, Wyoming Territory.

The great abundance of remains of turtles, of many species and genera, of fresh-water and terrestrial habit, obtained in Wyoming, indicates this region to have swarmed with these animals during the earlier portion of the Tertiary period. Crocodiles and lacertian reptiles were likewise numerous. The many mammalian remains found in association with the reptilian fossils mainly belong to tapiroid and carnivorous animals.

The Wyoming tertiary faùna presents a remarkable contrast with the later faunæ of the Mauvaises Terres of White River, Dacota, and of the Niobrara River, Nebraska. Among the large number of fossils from these two localities, rich in evidence of mammalian life, there occur the remains of a single species of turtle in each, and none of crocodiles or other reptiles.

Dr. Carter's collection, besides containing remains of *Trionyx guttatus*, *Emys Jeanesianus*, *E. Haydeni*, and *E. Stevensonianus*, and *Baena arenosa*, also adds two new turtles to the list. One of these is a species of Emys of the largest size, and exceeds any now living. The carapace has measured about two feet and a half in length, and the sternum about two feet. In honor of its discoverer, it may be named *Emys Carteri*.

The first and second vertebral plates of this species present an unusual, perhaps an anomalous appearance. The first is 4 inches long, and clavate in shape, with the narrow part foremost. The second is $2\frac{1}{4}$ inches long, and presents the usual hexagonal form reversed. The third plate, a little longer, is quadrate, with convex sides. The first vertebral scute is vase-like in outline, $5\frac{1}{2}$ inches long, $2\frac{3}{4}$ inches wide in front, $4\frac{3}{4}$ inches near the middle, and $3\frac{1}{2}$ inches at the back border. The second scute, of the ordinary form, is 5 inches long, and 4 inches wide.

The second turtle belongs to the recently characterized genus *Baena*, but is considerably larger than its associated species which have been described. The shell in its complete condition has been upwards of a foot and a half in length, and is seven inches and a half high. The sternum is flat, and about fifteen inches long. Its pedicles ascend at an angle of about 45°, and

are seven inches and a half broad. As in the living *Dermatemys*, and the sea turtles, they are covered with large scutes, four in number, as in *Baena arenosa*. The intermediate vertebral scutes are longer than broad—the third being 4 inches long, and 3½ inches wide. A peculiarity of the species is the undulating manner in which the costal scutes join the marginal scutes, and the sternal scutes one another. The species may be named *Baena undata*.

Dr. Carter's collection also contains some fragments of bones of a large mammal, which are so mutilated as to be hardly characteristic. A jaw fragment among them, with the retained fragments of the true molars, would appear to indicate a species of *Palæosyops* much larger than *P. paludosus*. In absence of other evidence, it might be viewed as a species of this genus, under the name of *P. major*. The true molars occupied a space of four and a half inches. The last molar measured an inch and seven-eighths fore and aft, and an inch transversely in front.

Dr. Carter had also sent some fossils to Prof. Leidy, among which were portions of jaw, with nearly full series teeth of *Hyrachyus agrarius*. This animal is related to the Tapir, *Hyracodon*, and *Lophiodon*. The formula of its dentition is the same as in *Hyracodon:* 7 molars, 1 canine, and 3 incisors. The true molars are like those of *Lophiodon*, except that the last lower one has a bi-lobed instead of a triple-lobed crown. Apparently the same animal has been indicated by Prof. Marsh under the name of *Lophiodon Bairdianus*. A fragment of a lower jaw containing the last premolar, and the first true molar, indicates a larger species of *Hyrachyus*, which may be named *H. eximius*. The crown of the last premolar is 7¼ lines antero-posteriorly, and 5½ transversely. The true molar has measured about 8½ lines fore and aft, and 6 lines transversely. The depth of the jaw fragment below the true molar is over an inch and a half.

Another fossil is a mutilated incisor, indicating a species of *Trogosus* rather more than half the size of *T. castoridens*, which may be named *T. vetulus*.

A femur of *Palæosyops paludosus*, in the collection, exhibits the third trochanter, characteristic of the unequal-toed pachyderms.

The astragalus of this animal almost repeats that of the living Tapirs.

Among the remains of Dr. Corson's collection there is the greater part of the lower jaw of a large crocodile, but too much broken to attempt to give an opinion in regard to its specific character, until it is in some degree mended or restored.

5. *Dredging in Lake Superior under the direction of the U. S. Lake Survey.*—Extensive dredgings were undertaken the past season in Lake Superior, from the U. S. steamer Search, under the direction of Gen. C. B. Comstock, Superintendent of the Lake Survey. Dredging was carried on from the shallow waters, especially along the north shore, down to 169 fathoms, the deepest point known in the lake. In all the deeper parts of the lake, the bottom, as shown both by the dredging and by the soundings

executed by the Survey, is covered with a uniform deposit of clay, or clayey mud, usually very soft and bluish or drab in color. Water brought from the bottom at many points was perfectly fresh; that from 169 fathoms gave no precipitate with nitrate of silver. The temperature, everywhere below 30 or 40 fathoms, varied very little from 39°, while at surface (at the time of the observations, during August) it varied from 50° to 55°. The fauna of the bottom corresponds with these physical conditions. In the shallow waters, the species vary with the varying character of the bottom, while below 30 to 40 fathoms, where the deep-water fauna properly begins, the species seem to be everywhere very uniformly distributed. The deep-water fauna, as might be expected from the unfavorable character of the bottom, is meager, and seems to be characterized rather by the absence of many of the shore species than by forms peculiar to itself. Some of the more interesting species occurring in deep water were: *Mysis relicta* Lovén, at various depths from 4 to 159 fathoms; *Pontoporeia affinis* Lindst., at nearly every haul from the shallowest to the deepest; a small undescribed species of *Pisidium*, down to 159 fathoms; several forms of dipterous larvæ, allied to *Chironomus*, down to the same depth; several species of Lumbricoid worms, of the genera *Tubifex*, *Sænuris*, and an allied genns; and a species of *Hydra*, which was found from the shore down to 159 fathoms. Of these, the *Mysis*, *Pontoporeia*, and *Pisidium* are identical with species found by Dr. Stimpson in his dredging in Lake Michigan, a short account of which was published in the American Naturalist for September, 1870. The species of *Mysis* and *Pontoporeia* I am unable to distinguish from specimens from Lake Wetter in Sweden. In the Swedish lakes, these species were associated with *Idotæa entomon* and *Gammaracanthus loricatus*, marine species, and were supposed by Lovén to have been derived from ancient marine species left in the lake basins by the recession of the ocean. The occurrence of these forms in Lake Superior, so far removed from the ocean, is certainly a very interesting fact in the geographical distribution of species, but one which I will not attempt to discuss in this brief notice. In the shallow waters many interesting species were obtained. Among these was a new species of *Crangonyx*, a genus closely allied to *Gammarus*, and heretofore known only from a few species found in the fresh waters of the old world, which occurred in 8 to 13 fathoms; and at the same depth, species of *Lumbricus*, *Nephelis*, *Procotyla*, *Gammarus*, *Asellus*, *Limnæa*, *Physa*, *Planorbis*, *Valvata*, *Sphærium*, *Pisidium*, etc. A full report will soon be published. S. I. SMITH.

6. *A. Featherman: Report of Botanical Survey of Southern and Central Louisiana.* In the *Annual Report of the Board of Supervisors of Louisiana State University, for year* 1870. New Orleans, 1871.—The Botanical Report, separately paged, fills 130 pages. Professor Featherman is Lecturer on Botany in the Uni-

versity, and Professor of Modern Languages. The general matter, which makes the principal staple of this Report, is of considerable interest, although the information afforded is in some cases decidedly trite. Our attention is concentrated upon the list of new species, twelve in number, which we enumerate, appending the names which they have previously received, some of them in works which Prof. Featherman has probably not had access to. We are indebted to the author for original specimens of some species and drawings of others, without which these determinations could hardly have been made. Taking the species in order:

Euphorbia Ludoviciana is *Phyllanthus Carolinensis* Walt.

E. Meganæsos is *E. maculata* L., a pretty well-marked, more erect, and smoothish variety, of our southern coast.

Sabbatia nana is *S. gracilis* Pursh, a dwarf form, approaching *S. stellaris.*

S. oligophylla is a slender state of *S. gentianoides* Ell.

Hydrolea leptocaulis is *H. affinis* Gray, Manual, ed. 5.

H. Ludoviciana is *H. ovata* Nutt.

Jussiæa Boydiana is *J. repens* L., a small form.

Tephrosia angustifolia, from the drawing is probably only a slender form of the next.

T. multiflora is *T. onobrychoides* Nutt.

Lilium Lockettii is *Crinum Americanum* L.

Œnothera paludosa, for lack of specimen and drawing, is not made out.

Helenium Seminariense is *H. nudiflorum* Nutt., that is, *Leptopoda brachypoda* Torr. and Gray. A. G.

7. *Dr. Rohrbach on Typha.*—Dr. Rohrbach, the monographer of *Silene*, of Berlin, has published a careful revision of the genus *Typha*. He recognizes 9 species, with 4 sub-species: 7 of the former are found in Europe, and 2 of these also in the territories of the United States, together with a sub-species, peculiar to the warmer parts of America.

Dr. R. has discovered that the fruits of 7 of the 9 species show a longitudinal groove, and burst open, emitting the seed, when placed in water: the two others possess no groove, nor do they open, the pericarp being adnate to the seed. Our species belong to the first section.*

The other characters on which he relies to distinguish the species are (1) the shape of the stigma, which is linear, spatulate or rhomboid; (2) the presence or absence of bracts (variable in shape in the same species) at the base of the female flower; (3) the proportional length of the stigmas, the perigonial hairs, and the just mentioned bracts, at the period of maturity of fruit; (4) the presence or absence of hair on the axis of the male inflorescence; (5) the pollen, whether in single grains or in 4 grains united; (6) the anatomical structure of the seed coats.

* The species with adnate pericarp are *T. Laxmanni* Lepechin (the earlier name for *T. minor* Sm.), throughout middle and southern Europe and Asia; and *T. stenophylla* F. & M., extending from Asia into Italy.

The shape of the leaves, and the contiguity or distance of the male and female inflorescence, do not furnish very reliable diagnostics.

Typha latifolia Lin., throughout the United States to the Pacific, and into Mexico. Axis of male inflorescence hairy; pollen grains in 4's; female flowers without bracts; stigma lanceolate-spatulate, much longer than the perigonial hairs; leaves flattish.

Typha angustifolia Lin., in the northern parts of the United States, southward only known in Louisiana. Axis of male inflorescence hairy; hairs linear; pollen grains single; female flowers subtended by bracts, which are of equal length with the perigonial hairs, and much shorter than the linear stigma; leaves convex on back.

Typha Domingensis Pers., from Texas, through the West Indies, and southward (not in the Old World), is a sub-species of the latter. Hair of the male inflorescence tapelike, broader upward; perigonial hair of female flowers slightly clavate (not seen in any other typha); seed coat a little different from that of *T. angustifolia;* leaves almost flat. *T. Teuxillensis* and *T. Tenuifolia* H. B. K., belong here.

A plate elucidates the differences of structure of the seed coats. An alphabetical index enumerates the names and synonyms, and refers them to their proper places. G. E.

III. Astronomy.

1. *Cordoba Observatory.*—The following are extracts from the recent official Report of the Director, Dr. B. A. Gould.

The Observatory is situated on a height or barranca, lying to the southeast of the city of Cordoba, at a distance of eight squares from the principal Plaza, and not far from the gardens of the National Exposition.

The ground plan of the edifice consists of a square, divided into four rooms of $5{\cdot}8^{m}$ a side each; and forming wings to the E. and W. two more rooms of $3{\cdot}6^{m}$ wide by $4{\cdot}2^{m}$ long, destined for observations in the plane of the meridian; and, at the respective extremities of these, two circular towers 6^{m} in diameter each; while in the north and south direction two smaller towers of 4 meters in diameter serve as prolongations to the edifice. These towers have revolving cupolas, and the whole of the edifice forms a cross terminated at its four extremities by as many towers. Its entire length is about 38^{m} in the direction E. to W., by a width of $24{\cdot}3^{m}$ from N. to S. The height of the larger towers is 6^{m} and that of the small ones only $5{\cdot}4^{m}$.

Your Excellency knows that the materials for the rooms which lie toward the E. and for the towers to the N. S. & E. were sent from the United States in June of the last year, with the exception of the masonry, which it was necessary to have constructed upon the spot. These materials, forming thus two-thirds of the edifice, were received in Cordoba in the 3d week in October, and this part of the edifice at this day, if not completely finished, is, at

least, in a state to be used. The remaining part, my friends in the United States, desirous to contribute to the good success and prompt realization of our establishment, have undertaken to contribute, and only thus has it been possible that these materials should be shipped in the first vessel which sailed this year from the United States for Rio de la Plata. I am notified that these were landed April 1st at Buenos Ayres; nevertheless the public calamity which has weighed upon that city and the restrictions which have, in consequence, been imposed on trade in other parts of the republic, have thus far delayed the reception of this last part of the edifice. When they reach us their putting together will be the work of a few weeks, thus completing the Observatory.

It would not be possible for me to recount here the efficient aid which your institution has received from its commencement as well from the authorities of the Province as from the citizens of Cordoba. The latter authorized me on my arrival to choose a lot of land of adequate size wherever it might be considered most convenient, and have since conveyed a square lot of $216{\cdot}9^{m}$ a side.

Our principal instruments, besides clocks, chronometers, chronographs and meteorological apparatus, are the meridian circle, the great equatorial, the small equatorial and the photometer. All these are now in the country; nevertheless we have not been able to avail ourselves of any one of them. Without an embargo, one month more will suffice in my judgment for their collocation.

Our meridian circle was made by Messrs. Repsold & Son of Hamburg, whose workshops are indisputably the most reliable for instruments of this class. The length of the telescope is $1{\cdot}484^{m}$; the aperture of its objective 122^{mm} and the divisions of the circles permit the appreciation of a single second by means of the microscopes. The whole apparatus is mounted on two pillars of white marble from the Sierra of Cordoba, which are laid in solid masonry cement, and are $1{\cdot}61^{m}$ high by $0{\cdot}71^{m}$ wide. Though not the greatest nor the most costly of our apparatus, nor indeed of the greatest magnifying power it is the principal instrument in a certain sense, since with it will have to be executed the greater part of our labors in the next 2 or 3 years. The great Equatorial is the principal instrument, if we take into consideration its imposing size and its magnifying power. Not having ordered it early enough, we had not supposed that it would be finished within the brief time at our disposal, yet I have had the fortune to be able to procure an objective of great excellence, the work of Fitz, a distinguished optician of New York. Its power has been tried by the astronomer Rutherfurd. The celebrated mechanicians, Clark & Sons, have undertaken to mount it, which they have effected with the most complete success. The telescope has an aperture of 28^{cm}, a focal distance of about $3^{m}{\cdot}63$, and is provided with clockwork. It stands upon a pillar of white marble of a height of $1{\cdot}91^{m}$, under the revolving dome of the east tower. The small Equatorial has an aperture of about 13^{cm}, and is provided with two circles minutely divided, but it is without the clockwork apparatus. It also was made by Clark & Son, and is to be placed in the south tower.

In the north tower will be placed the photometer. This small, yet most beautiful, instrument is the work of Ausfeld of Gotha, in Germany, who constructed it under the immediate supervision of the inventor himself, Professor Zoellner of Leipsic. This instrument, as well as the spectroscope constructed for our observatory by Tauber of Leipsic, and which we have not yet received, is the property of the American Academy of Arts and Sciences of Boston, which has entrusted me with the sum of $500 to procure the necessary apparatus for the study of the light of the southern stars, with directions to turn over to them the apparatus acquired with this sum, or a similar amount, as may appear to be most convenient. I do not disguise the confidence which I cherish, that these instruments may be retained as the property of the National Observatory, in view of their rare beauty and excellence.

At a former time I brought it to the knowledge of your Excellency, that the great delay in the placing of the instruments and finishing the building induced me to form a plan of investigations which at the same time that it should bring into action the "personnel" of the Observatory might also conduce to useful and effective results, even without the aid of the large instruments. I informed you of the course adopted in this respect. Without loss of time there was commenced a detailed and laborious series of observations with the naked eye with the object of forming a catalogue of all the stars thus visible in the Southern heavens, according to position and degree of brilliancy and to construct thus a system of maps which shall represent the aspect of the heavens in these latitudes. Such maps do not now exist, nor have there been many accurate determinations of the quantity of light of the stars situated to the south of the Celestial Equator. My object is to supply this want, and the results so far obtained have so far exceeded my expectations that I seriously doubt if we could have done more for the progress of the science if instruments had been at our service. As far as I can estimate, two-thirds, at least, of the labor of observation and computation which this work demands is concluded—thanks to the intense application of my assistants, whose devotion in this regard is no less honorable to themselves than useful to the new institution. I hope that this work will be concluded and given to the press before the end of the current year. The results will appear in a series of charts of the heavens, as they present themselves to the naked eye, and which will comprehend the entire firmament from 10° north of the Equator to the south pole, and will be accompanied by a catalogue of the stars, arranged by constellations, which shall indicate the position and brilliancy of each one of them. This work, the first fruit of the new institution, will bear the name of "Argentine Uranometry," and no exertion on my part shall be omitted that its publication may be a stamp of honor to the nation, which with so much zeal and enlightenment is taking its first steps in the path of a higher civilization.

I have found the heavens of Cordoba less serene and more subject to clouds than I had hoped according to the received data,

nevertheless when they are clear they are of an admirable transparency, as your Excellency may appreciate from the fact that we have observed and reduced to the maps about 4500 stars between the 10th degree of north declination and the south pole, while the Uranometry of Argelander, which contains all the stars visible without instruments between the north pole and 30° of south latitude, contains only 3256 stars. If the Government decides upon the publication of these results, as I cannot doubt will be the case, I am of opinion that the new process of photolithography will supply the most economical and accurate method of executing the maps—this consisting in engraving on stone by means of photographic reagents the maps drawn on a larger scale.

I trust that the completion of the *Uranometry* will occupy us only a few months more, though naturally it may be somewhat retarded by the distraction of our forces in using the instruments which are soon to come into activity. Immediately upon concluding the slow and detailed observations which the collocation of the instruments demand, I propose to commence a systematic study of the southern hemisphere, beginning at the limit to which northern astronomers have advanced. The very valuable observations taken at Cape Town, at Madras, Melbourne and Santiago will serve for a beginning to this labor, which is designed rather for the formation of a complete catalogue of all the stars within a certain limit of brilliancy, than for the attainment of the greatest possible precision in the determination of the positions of a smaller number. This work proceeds by the observation of "zones" of stars, which are intended to embrace all of a certain brilliancy, situated in a given region of the heavens. The same proceeding is successively repeated up to the definitive exploration of the entire space between the proposed limits. A similar examination has been made by the German astronomers, Bessel and Argelander, in all the heavens to the north of the 30th degree of south declination; and by the American astronomer, Gilliss, in Santiago, in Chili, in the region extending from 23°, more or less, to the vicinity of the South Pole. Though these last mentioned observations have not been published, yet they are at this moment in preparation for the press on account of the Government of the United States. If the Argentine National Observatory could coöperate by filling up the space between the two series of zones above-mentioned, so as to form a continuous whole, the scientific world would appreciate the work, and offer its tribute of gratitude through long years to come.

The National Congress has without solicitation from Dr. Gould provided for an observer's dwelling upon the Observatory grounds.

The report goes on to suggest two ways by which the Observatory can be of especial use in developing the science of the country—1st, by the telegraphic determination of longitudes; and 2d, by the formation of a system of meteorological observations throughout the Republic.

President Sarmiento and the Minister of Public Instruction have officially approved the report, and promise to put the institution into relations with the national establishments of public instruction, in order to carry on a full system of meteorological observations.

2. *Encke's Comet.*—A view of Encke's comet was obtained at the Observatory of the Sheffield Scientific School on the evening of Oct. 13th. It was barely visible as a diffuse nebula. The following places of the comet, taken from an ephemeris by S. von Glasenapp of Pulkowa, and published in No. 1854 of the *Astronomische Nachrichten*, may be of interest to observers.

0^h Berl. m. t.	A.R.			Decl.			log. dist. to ☉	log. △	$\frac{a^2(a-1)^3}{r^2\triangle^2}$
	h	m	s	°	′	″			
Aug. 18	2	3	35·83	+23	32	33·1	0·33419	0·21013	0·58
Sept. 20	2	0	14·85	30	36	41·3	0·25522	9·97354	2·37
Oct. 21	0	21	52·73	38	54	38·5	0·14690	9·66369	17·10
29	23	18	44·39	38	54	48·4	0·10987	9·58273	29·47
Nov. 2	22	40	41·93	37	39	10·8	0·08931	9·54811	37·06
6	22	0	21·40	35	16	23 6	0·06716	9·52021	47·80
10	21	19	56·91	31	44	32·8	0·04317	9·50100	58·33
14	20	41	26·49	27	14	9·9	0·01707	9·49178	68·63
18	20	5	57·91	22	4	26·7	9·98850	9·49254	77·96
22	19	33	47·49	16	36	17·1	9·95703	9·50334	85·84
26	19	4	38·22	11	6	31·3	9·92215	9·52258	92·19
30	18	38	3·47	5	46	7·2	9·88322	9·54957	97·43
Dec. 4	18	13	41·66	+ 0	41	12·7	9·83947	9·58379	101·81
16	17	15	19·72	−12	37	13·7	9·67272	9·72983	111·99

After reaching the perihelion December 29th, the comet will be too near the sun to be easily observed. In 1829 the comet was first seen with a light-intensity of 1·2. In 1868 it was first seen with a light of 2·2. On the night of Oct. 13th the light was about 10, according to von Glasenapp's ephemeris.

3. *Discovery of new Planet.*—Dr. Luther of Bilk discovered a new planet (117) on the 14th of Sept. It was equal in brilliancy to a star of the 11th magnitude.

IV. Miscellaneous Scientific Intelligence.

1. *Midway Islands, in the North Pacific.*—It is well known that the Hawaian line of islands is continued beyond Kauai in a series of coral islands or atolls, which, together with the high islands from Kauai to Hawaii, make the whole length of the Hawaian chain full 2000 miles. Some of these islands were surveyed by the U. S. Government in 1867, with reference to harbors and a place of depot for coal, to serve as a half-way station, for the North Pacific line of steamers. We take the following facts respecting the three islands particulary surveyed, from the Report to the Bureau of Navigation, in December, 1867, of Capt. Wm. Reynolds, U. S. N. These three islands are Ocean Island in latitude 28° 25′ N. and longitude 178° 25′ W; Midway or Brooks Island, in 28° 15′ N. and 177° 20′ W.; and Pearl and Hermes Island in 27° 50′ N. and 175° 50′ W.

In Brooks Island, which was the best of the three as regards harbor, the encircling reef is 18 miles in circumference. On the west-north-west side, for three miles, the reef is mostly wanting, and there are 3 to 10 fathoms water. At the northwest point there are breakers; and then from there, along by the east side, for 4¼ miles, there is a steep wall of compact coral rock, of about 5 feet elevation, and only 6 to 20 feet wide, where examined; beyond this, the wall becomes a line of detached rocks, and for 2 miles is hardly above tide level, and then for another 2 miles under water, except at low tide; but for the next 4½ miles, along the southern and southwestern sides, there is again a continuous wall for 4½ miles. There is no vegetation along the wall. Whether this wall indicates an elevation of the island or not, it is difficult to say. It is more probable that there has been a subsidence of four or five feet, and that the wall is only the ruins of the coral rock that formed the dry land of an atoll once in much better condition.

The only harbor entrance is on the west or leeward side. The harbor—called Welles Harbor—is rather larger than that of Honolulu (of Oahu), and as safe, but has not quite as much water on the bar—the depth being from 21 to 16 feet at low water. The entrance between the reefs is 800 feet. On the southwest reef there is a small island, called Middle Brooks Island, whose highest point is 15 feet above the sea; its vegetation is shrubs and grasses. The lagoon is 2 miles long and 1½ miles in its greatest width. There are many clumps of coral with 1 to 2 fathoms over them; but the rest of the bottom is of white coral sand.

Turtle abound on the island, but seals were seen only occasionally. Birds were very numerous, and the young birds were so many as to make it difficult to walk any distance without trampling on them. There is but little guano, and this is probably owing to the condition of the reef.

Ocean Island is much like Brooks, in having a wall of coral rock on its northwest, north and east sides; the north side reef is at low tide level. There is no ship entrance to the lagoon. There is a green islet at the southeast corner like that of Brooks Island, its height above the sea 10 feet. The reef has a circuit of 14¾ miles.

Pearl and Hermes reef closely resembles the other two, but the wall is rather a line of detached rocks than a continuous parapet. The circumference of the reef is 42 miles, the length from east to west being 16 miles, and that from north to south 16 miles.

2. *Eruption of the Volcano of Colima in June*, 1869;* by Dr. Charles Sartorius.—To the northwest of the town of Colima rise, above lower mountains, two lofty volcanic peaks, the more easterly, capped with snow, being 3,790 metres (12,434 feet) in height, the more westerly, with a conspicuous crater, 3,580 metres (11,745 feet). The latter had an eruption in the year 1818, but has since remained in repose, though thin clouds of smoke have often ascended from its summit.

On the 12th June, 1869, a dense smoke issued from the crater, and at night a bright light was visible at its mouth; detonations

* Smithsonian Report, 1869, p. 423.

like the discharge of distant artillery were heard, but no concussion of the earth took place. On the 13th there was observed from the hacienda (farm) of San Marcos, four leagues distant from the volcano, on its northeast side, at the foot of the steep cone, a glowing heaving (*Anschwellung*) of the surface, which continued to increase, and displayed intensely luminous clefts, from which were ejected smoke and red-hot stones, extending in the direction of the snowy peak above mentioned.

The civil engineer, Ricardo Orosco, ascended the volcano on the 15th of June, accompanied by two servants and a guide. At 6 o'clock in the morning he left San Marcos, and reached at 12 o'clock a plain at the foot of the steep cone, where he left the horses. A heavy storm was prevailing, the temperature of the air being 10° Réaumur, (55° F.) On a second small plain, upon the northeast side of the mountain, was the new upheaval, which ascended to the scarp of the cone and stretched in the direction of the snowy peak, the latter being 4,500 metres (2¾ miles) distant. The upheaval in question seemed to be some 35 metres (114 feet) high and 230 metres (754 feet) broad, forming a flattened arch. The appearance was that of a wild mass of volcanic, red-hot rocks heaped one upon another and constantly in motion, not unlike freshly-burnt lime when sprinkled with water. The rocks which rolled down were, on cooling, of a gray color. A piece broken off rang like glass, and was vitreous and porous. In the middle of the upheaved mass the movement was strongest; there large clefts and intense light were displayed, while engulfed stones, which were swallowed up in great masses, were followed by a noise as of violent wind and by clouds of smoke, sometimes blue, sometimes yellow. The temperature of the air in the vicinity was 42° R., (126° F.) The stones in the midst of the heaving mass seemed to be softened, though not melted, and no flow of lava took place. Orosco ascended the cone in order to observe the phenomenon from above. This cone is very steep, and consists of sand and volcanic rubble. The temperature on the summit, which was reached at 2 o'clock p. m., was found to be 4° R., (41° F.) From hence the whole of the new upheaval could be surveyed. In the middle of it the most vehement movement was in progress, attended by the constant upheaving and descent of rocky masses, fire, and blue and yellow columns of smoke.

The upper (ancient) crater has a diameter of 150 metres (492 feet), descends in a cone-like form, and shows around its circumference many fissures and rifts. From the center and walls arose a dense sulphurous vapor. The gases from the new theater of eruption had a smell like that of burning stone-coal.

The descent was very toilsome on account of the rolling stones. At 3.30 p. m. the horses were reached, and at 9.30 the hacienda of San Marcos, where many were waiting to learn the result of the expedition. The report of Orosco was, that the district was threatened with no danger, as no lava was issuing, and the fissures being open gave no reason to fear any explosion from the tension of confined vapors. Later explorers of the volcano found a fissure

from the new upheaval to the upper peak, one to three feet wide and about three feet in depth, but neither heat nor vapor issuing from it. The latest reports inform us that the same phenomena in general continue to present themselves, but that such volumes of fetid gases issue from the fissure, that the inhabitants of the district were forced to leave their abodes. Cows and sheep were killed thereby, so that it was found necessary to drive away the herds from the neighborhood of the volcano.

3. *The Variations of Gravity in the Western Provinces of Russia;* by A. SAWITSCH. (Abstract, M. N. Roy. Astron. Soc., June 9.)—A great arc of the meridian having been measured in Russia with all the precision which modern methods of observation will admit of, it became an interesting subject to examine the variations of the intensity of gravity in the districts traversed by this arc, and to compare the progress of those changes with the variations which are observed in the direction of gravity determined at several stations by astronomical observations and geodetical operations. An extensive series of pendulum observations was therefore arranged by the Academy of Sciences of St. Petersburg, to be made at certain stations between Tornea in Finland, and Ismail in Moldavia, selecting only those points of which the geographical positions and elevations above the mean level of the sea were determined in connection with the great arc of meridian. The observations between Tornea and St. Petersburg were made during the summer of 1865 by M. Sawitsch and M. Lenz; those between St. Petersburg and Ismail were made in 1866 and 1868 by M. Sawitsch and M. Smyslof.

M. Sawitsch gives in detail the formulæ used by him in the reductions, and also the results of the observations, which are given for twelve different stations situated between 65° 51′ and 45° 20′ north latitude. At St. Petersburg the length of the seconds' pendulum found directly from the observations is 440·958 Paris lines, the latitude being 59° 56′ 30″.

"Our object was not so much to determine the absolute length of the pendulum as to collect new data on the variations of gravity, and to compare them with those which have been found at other stations on the terrestrial surface. We know that at London the length of the simple seconds' pendulum has been determined with great precision by Capt. Kater and by General Sir E. Sabine; and that the measures made in Great Britain by M. Biot agree perfectly with those obtained by the English savants, while those made in France by the English savants give the same results as those of M. Biot. To these determinations we may also add the observations made by travelers and naval officers in different parts of the world. To connect our experiments with the preceding system of researches, without a breaking of continuity, we prefer not to adopt our direct determination of the length of the pendulum at St. Petersburg, but rather that which was deduced from the oscillations of a similar invariable pendulum, observed by M. le Comte Luetke at St. Petersburg and at the Royal Observatory at Greenwich; the difference between the length of the

seconds' pendulum at Greenwich and London having been accurately determined by Sir E. Sabine. Thus the length of the simple seconds' pendulum being known at London, we can calculate its length at St. Petersburg according to the relation of the squares of the numbers of infinitely small oscillations which the comparison pendulum, reduced to the same temperature *in vacuo*, has made at each of the stations in a mean day. In this manner, the calculation gives for the length of the simple seconds' pendulum at St. Petersburg 39·16975 English inches or 441·0319 Paris lines. Assuming this length, we have deduced, as the result of our observations, the values contained in the first three columns of the following table.

Place of observation.	Latitude N. ° ′ ″	Longitude E. from Greenwich. h m s	Length of the Seconds pendulum in Paris lines.	Errors. Paris lines.
Tornea,	65 50 43	1 36 54	441·2525	+0·0200
Nicolaistadt,	63 5 33	1 26 26	441·1293	−0·0141
St. Petersburg,	59 56 30	2 1 14	441·0319	−0·0017
Réval	59 26 37	1 39 1	441·0190	+0·0033
Dorpat	58 22 47	1 46 54	440·9762	−0·0002
Jacobstadt,	56 30 3	1 43 4	440·8900	−0·0157
Wilna,	54 41 2	1 41 12	440·8353	−0·0001
Bélin,	52 2 22	1 40 52	440·7268	−0·0035
Krémenetz,	50 6 8	1 42 54	440·6533	+0·0017
Kaménetz-Podolsk,	48 4 39	1 46 18	440·5844	+0·0160
Kischinef,	47 1 30	1 55 18	440·5278	+0·0030
Ismail,	45 20 34	1 55 16	440·4479	−0·0071

To examine the accuracy of each of the results M. Sawitsch has compared the length of the pendulum observed at each station, with the corresponding length obtained from the formulæ given in his paper. The residuals are as given in the fifth column of the preceding table; the sign + denoting that the observed length is greater than the calculated length.

The sum of the positive residual errors is +0·0440, and of the negative residual errors −0·0423.

Thus the formula agrees well with the equations of condition. With regard to individual errors, they depend upon errors of observation and upon anomalies in the intensities of terrestrial gravity; but it is difficult to discover in the differences given above any certain traces of those anomalies and of the local causes which produce them.

"In the work of W. Struve on the arc of meridian between the Danube and the Arctic Sea is a detailed discussion of the latitudes of the principal places between the North Cape and the Danube. The differences in latitude found directly from the astronomical observations vary only ± 1″·75 from those deduced from the geodetical operations. Athough these differences are very much larger than the errors of observation, they are not as great as those which may be found in corresponding operations in other countries. Our stations are in the neighborhood of the places discussed by M. Struve; so that it appears that in the great plains of Western Russia the directions and intensities of gravity are not subject to anomalies which change sensibly from one of our stations to another."

4. *Zoological Results of the* 1870 *Dredging Expedition of the Yacht "Norna" off the coast of Spain and Portugal;* by W. S. Kent.—A detailed list of the numerous species collected throughout the cruise being in course of preparation for the more technical and exhaustive report to be presented to the Royal Society, I here propose, commencing at the lowest animal group, to briefly enumerate some of the more important forms taken, adding such remarks on the characters or connecting circumstances which render them more especially deserving of attention. Of all, the sub-kingdom of the Protozoa has perhaps furnished us with the most abundant and valuable material, the sponge class in particular contributing many novelties. Before leaving British waters even, the few hours spent in shore-collecting at Guernsey, already alluded to, resulted in the accession of three new species of the genera *Isodictya* and *Hymeniacidon*, which I have placed at the disposal of my kind friend Dr. Bowerbank, to be described by him in his supplementary volume of the "British Spongiadæ," now closely approaching completion. The moderate depth within the Laminarian and Coralline zones, from the shore line down to fifty fathoms, at which we collected and dredged in Vigo Bay and afterward farther south in the neighbourhood of Setubal and the Sado river, proved remarkably productive of species belonging to the same group, as also to that of the Calcarea or calcareous spiculed sponges, including *Sycon* and *Grantia*, &c. The most interesting of any, however, were the species belonging to the Hexactinellidæ, or hexradiate spiculed sponges, of which the beautiful *Euplectella* and *Hyalonema* form familiar examples. Nine species belonging to this group were obtained at a depth varying from 400 to 800 fathoms off Cape Espichel and Cezimbra, including *Hyalonema*, *Dactylocalyx*, *Aphrocallistes Bocagii*, *Lanuginella pupa*, and four other species new to science, three out of which necessarily constitute the types of new genera, the residue again furnishing data enabling us better to appreciate the characters and distinctions of those previously made known to us. The form belonging to the same group, and described by myself as *Pheronema Grayi*, and exhibited at the last meeting of this Association, is the most conspicuous among all these on account of its size, and I would here add a few more words in reference to this particular type. Since last year I have been afforded the opportunity of examining and comparing my own with numerous specimens of Prof. Wyville Thomson's *Holtenia Carpenteri* taken in the North Sea and also in the Atlantic, and from an evolutionist's point of view, this examination has led me to regard my specimens as holding rather the rank of a well-marked local variety than of a distinct species as I at first premised. A comparison of the specimens, now placed side by side in the British Museum collection, will, I think, suffice to prove to all those interested in this subject how strongly marked as varieties these two forms are. Meanwhile, the generic name of *Pheronema*, adopted by myself, I still retain, as I consider both Prof. Wyville Thompson's form and my own to be local varieties of another species

first described by Dr. Leidy of Philadelphia as *Pheronema annæ*, and a letter recently received from Dr. Leidy himself more fully convinces me of this, though he has not yet bestowed on it the minute microscopical investigation of its structure needed for the effectual clearing up of this, at present, doubtful point.

In my description of other sponges belonging to this same Hexactinellate group, read before the Royal Microscopical Society, and published in their "Transactions" for November, 1870, I have, in creating a new genus and species, *Askonema Setubalense*, erroneously associated Prof. Thompson's name with it as having once pronounced the form to be of vegetable and not animal organization. The mistake arose from the misconception of a name singularly similar in euphony as pronounced to me by Prof. du Bocage, and I here avail myself of the opportunity of rendering Prof. Wyville Thompson that *amende honorable* I feel myself in duty bound to accord to him.

Passing next to the class of the Foraminifera, our gatherings have been remarkably rich both from the coralline and abyssal zones, the latter furnishing us with numerous arenaceous types (*Rhabdomina*, &c.), and the former being notably abundant in species and varieties of *Lagena* and *Cristellaria*. Many of these forms are new to science and await description.

The Cœlenterate sub-kingdom has likewise furnished several new and rare forms, including among the latter category an example of *Hyalopathes pyramidalis*, M. Edw., one of the Antipathiidæ now represented for the first time in our national collection, if not in this country. In the Alcyonarian group, *Veretillum cynomorium*, first taken sparingly in Vigo Bay, and afterward abundantly in the Laminarian zone near Setubal, excited our warmest admiration.

Nothing can exceed the beauty of the elegant opaline polyps of this zoophyte when fully expanded, and clustered like flowers on their orange-colored stalk; a beauty, however, almost equalled by night when, on the slightest irritation, the whole colony glows from one extremity to the other with undulating waves of pale green phosphoric light. A large bucketful of these Alcyonaria was experimentally stirred up one dark evening, and the brilliant luminosity evolved produced a spectacle too brilliant for words to describe. The supporting stem appeared always to be the chief seat of these phosphorescent properties, and from thence the scintillations traveled onwards to the bodies of the polyps themselves. Some of the specimens of this magnificent zoophyte measured as much as ten inches from the proximal to the distal extremity of the supporting stalk, while the individual polyps, when fully exserted, protruded upwards of an inch-and-a-half from this inflated stalk, and measured as much as an inch in the diameter of their expanded tentacular discs.

Numerous Polyzoa were also dredged up from the various depths, many of which remain yet to be identified; but the allied group of the Tunicata has perhaps furnished by far the most inter-

esting material of the whole molluscoidan sub-kingdom; surface-skimmings one morning near the mouth of the Sado river having rewarded us with numerous specimens of an *Appendicularia*, which, from notes and sketches made at the time of their capture, I have since found to have presented phenomena seemingly not yet observed by any other naturalist. Hitherto these organisms have been presumed to constitute a distinct genus of Tunicata *inter se*, or otherwise to be the larval conditions of higher forms. My own observations, however, recorded in the last July number of the "Quarterly Journal of Microscopical Science," have led me to believe that they are the free swimming reproductive zooids of higher Tunicates, bearing the same relation to them as many free swimming *Medusæ* do to some stationary hydroid colony. At the greater depth of 600 and 800 fathoms, various species of *Terebratulæ* were taken as representative of the class Brachiopoda.

Ascending yet higher to the sub-kingdom of the Mollusca, a large variety of interesting species rewarded our researches. Included among these were—*Fusus contrarius*, a common fossil of the Norfolk crag recently discovered in the living state in Vigo Bay by Mr. McAndrew, and dredged by us in the same locality; also a species of *Cassis*, remarkable from its being more closely allied to *C. Saburon* and other species inhabiting the Japanese and Chinese seas than to any of its Mediterranean or Atlantic congeners. This circumstance of its affinity is the more remarkable when associated with the occurrence of a species of *Hyalonema* (*H. lusitanica*) off the same coast, likewise scarcely distinguishable from the more familiar Japanese form *H. Sieboldi*.—*Nature, Oct.* 5.

5. *Destruction of the Museum of the Chicago Academy of Sciences.*—Among the devastations of the great Chicago fire, not the least in importance was the burning of the Museum of the Chicago Academy of Sciences. The building was supposed to be fire-proof, but a letter to Professor Agassiz from Dr. Wm. Stimpson, the Curator, says, "it collapsed like a bubble in the intense heat, as did indeed all other 'fire-proof' buildings in the city." The Museum contained the largest collection of Crustacea in the world, "filling," as the same letter says, "more than ten thousand jars," included the very extensive suite of specimens and species, even to the types of all the many new species, gathered by Prof. J. D. Dana in the Wilkes Exploring Expedition in the Atlantic and Pacific Oceans, the basis of his Report of 1,500 pages in 1855 on that subject; and also the large collections made by Dr. Stimpson himself in his cruise in the Ringgold Expedition to the North Pacific, besides his recent collections from the Gulf of Mexico, and specimens from various other sources. There were also the alcoholic specimens of other invertebrata, obtained by the Wilkes Exploring Expedition, and those of Dr. Stimpson's own Pacific and Gulf collection. There were also in the Museum, unfortunately, the Crustacea dredged up by Mr. de Pourtales in his late dredging expeditions, these having been sent there for description and a final report.

Dr. Stimpson writes, that besides his private collections, all his books and his manuscripts, the result of twenty years of labor, are gone. He says, "Everything of value that I had in the world was deposited in the building for safety, and I am now left utterly destitute." Dr. Stimpson had published only brief descriptions of the species collected by him in the North Pacific expedition, and had been engaged during the past two years, along with an artist, in preparing for the press a full report, with detailed illustrations of all the species. These are among the lost.

Dr. Stimpson is one of the ablest and most energetic workers in zoology in the country; and he deserves something more than ordinary commiseration. Should a scientific library be restored to him by gifts from others over the world, and from owners of duplicate copies of zoological works, it would not be more than a just return for all his unwearied labor in the cause of science.

6. *Earthquake in New Jersey, Delaware, and Pennsylvania;* by W. C. Taylor. (From a letter to Prof. Newton, dated Haddonfield, N. J., Oct. 10, 1871.)—The earthquake which was felt in Delaware yesterday was very distinctly observed in this place. The time noted by one of our school teachers here, an exact observer, was 20′ before 10 A. M., the same as that stated by the Wilmington writers.

The noise heard in Haddonfield was similarly described by all observers as resembling the dragging of heavy furniture over the upper floors of the houses, or the rumbling of heavily-laden wagons along the streets. It was sufficiently startling to bring some persons to their doors, to look for the cause of the disturbance.

In a subsequent letter, Mr. Taylor states that the shock was felt also in Philadelphia, at the same time, 20′ before 10. The shock was felt at Dupont's powder mills, where there was not an explosion, as has been suggested.

OBITUARY.

Peter D. Knieskern, M. D., died at Shark River, New Jersey, on the 12th of September last. He was born at Berne, Albany county, N. Y., June 11, 1798. When a boy his love of nature and of books was such that his father despaired of making a farmer of him, and he consequently, but with great difficulties, found his way to a liberal education. He took his medical degree about the year 1829 or 1830, at Fairfield (College of Physicians and Surgeons of the Western District,) N. Y., then a famous school of medicine. He early became passionately fond of Botany, was an indefatigable collector and a keen observer. Few botanists have excelled him in their knowledge of the plants of the region in which he resided, and none in zeal, simplicity and love of science for its own sake. Neither poverty nor want of opportunity and companionship appear to have discouraged him, although they restricted his researches to a comparatively narrow field. He first established himself, as a physician, at New London, then removed to Oriskany, N. Y. He published in the Report of the Regents of the University for 1842, a catalogue of plants of

Oneida county, of which Dr. Torrey took occasion to speak in the highest terms, while also acknowledging the most efficient aid which Dr. Knieskern had rendered him in the preparation of his Flora of the State of New York. In the year 1841, upon Dr. Torrey's recommendation, he removed to a new field, which seemed to offer an opening for a medical man, while it afforded a richer harvest of rare plants than any other district in the Northern Atlantic States, viz: the Pine barrens of New Jersey. He lived first at Manchester, Ocean county; six years later he removed to Squam Village, Monmouth county, and six years afterwards to Shark River, where he remained to the end. Over this whole prolific and peculiar pine-barren region he botanised with utmost assiduity and skill, and amassed a large number of specimens, which, as age advanced have accumulated on his hands, and which, it is hoped, may be disposed of for the benefit of his family. It should be especially rich in Carices, to which he devoted much attention; and several most interesting species are almost peculiar to that district or even to some few localities in it. The character of that flora may be gathered from the catalogue of the plants of parts of Ocean and Monmouth counties, New Jersey, which Dr. Knieskern published, and from a greatly extended edition of it which subsequently appeared as a contribution to the Geological Survey of the State. What particular course will be adopted in reference to these botanical *reliquiæ*, the writer of this notice is at present unable to say. But those wishing for information may address communications to him, or, which is better, to the Rev. Samuel Lockwood, Freehold, New Jersey, to whom we are indebted for the facts relative to Dr. Knieskern's later life. He informs us that his lamented friend died of paralysis, in his 74th year, with unclouded intellect, the same simple-hearted, truly but most unpretendingly good and faithful man that he had always been. At least two species of his own discovery bear his name, and both are of the Sedge Family, in which he especially delighted. These, and the repeated mention of his discoveries in various works will keep his memory green and name perennial in American Botany long after the few surviving companions of his youth have passed like him to another world. A. G.

John Edwards Holbrook, of South Carolina, died at Norfolk, Massachusetts, on the 8th of September. He was born at Beaufort, S. C., in 1794, and graduated at Brown University; and since 1824 has occupied the position of Professor of Anatomy in the State University of South Carolina. He is chiefly known from the extent and magnificence of his works upon the reptiles of North America, and upon the fishes of South Carolina. Of these the first-mentioned appeared in its completed form in 1842, occupying five quarto volumes, and giving figures and descriptions of all the species of reptiles then known in the United States—about one hundred and sixty in number. Some volumes had been previously published and canceled by the author in consequence of their supposed imperfection. The advance in our knowledge of American

reptiles since that time may be learned from the fact that we are at present acquainted with not far from five hundred species.

The work on the fishes of South Carolina was equally difficult to bring to a conclusion satisfactory to its author, several numbers having been canceled and replaced. The publication, indeed, was never entirely finished, the commencement of the civil war having interfered with its completion, although, as it stands, it embraces the only available series of illustrations of the greater part of the Southern species. It is said that a eulogium upon Dr. Holbrook is to be delivered before the Boston Society of Natural History by Professor Agassiz at some future day.—*Harper's Weekly.*

James De Carle Sowerby, died August 20th, at the age of 84. Mr. Sowerby was well known as a naturalist; still better, however, as an artist, his illustrations of shells, plants, and other objects of natural history being considered of superior excellence, and gracing the pages of many of the more important works of natural history published in England for many years past. It was in the branches of conchology and botany that he was most prominent; in the latter department, mainly in connection with what is known as "Sowerby's English Botany," intended to give a life-size colored figure of every British plant; and of which eighty-one fasciculi, or ten volumes, are already published at a cost of over $10,000 per set.—*Athenæum.*

Sir Roderick Impey Murchison, the eminent geologist, died in London on the 23d of October, aged 79, having been born in 1792.

V. Miscellaneous Bibliography.

1. *The Linn-Base decimal system of Weights, Measures and Money;* by W. Wilberforce Mann. New York, 1871. pp. 20.—This system is based upon the following, as principal units: the *linn*=1 dekameter; the *arr*=1 sq. dekameter; the *soll*=1 *capp* =1 liter; the *pondd*=1 kilogram, and the *monn*=5 francs. The multiples ascend by tens by the Greek prefixes, Hena-, Dua-, Tria-, Tetra-, &c., and the parts descending by tens are denoted by Latin prefixes, Primi-, Bini-, Tern-, &c.

2. *Earthquakes, Volcanoes and Mountain building;* by J. D. Whitney. 108 pp. 8vo.—Three articles published in the North American Review. A valuable and interesting discussion of many of the views connected with the three subjects mentioned in the title, with the results of the author's own important investigations.

3. *The Minerals and Geology of Central Canada: a handbook for practical use;* by E. J. Chapman, Prof. in University College, Toronto, and Consulting Mining Engineer.—This is a second and enlarged edition of Professor Chapman's Hand-book. It contains the only systematic account of Canadian Mineralogy, and a brief sketch of its Geology.

Three and four place tables of Logarithmic and Trigonometric Functions. By Prof. J. M. Pierce, of Harvard University. Ginn Brothers, Boston. pp. 16.

Elements of Trigonometry. By Prof. E. Olney, of the University of Michigan, Shelton & Co., N. Y.

General Geometry and Calculus. By the same author and publishers.